

Mangroves of Kerala, India

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Abstract

The present study reports 15 true mangrove and 49 mangrove associate species from Kerala coast. True mangrove species belonged to nine genera under seven families. Detailed descriptions, illustrations, notes on distribution and updated nomenclature of the true mangrove species are provided. Mangrove associates are listed. Five true mangrove species earlier reported from Kerala viz.: *Bruguiera eriopetala*, *B. malabarica*, *B. parviflora* and *Ceriops tagal* could not be located during the present investigation. *Bruguiera gymnorrhiza*, *B. sexangula*, *Excoecaria indica*, *Lumnitzera racemosa* and *Sonneratia alba* are found very rare along Kerala coast. Developmental and anthropogenic activities, grazing and widespread prawn farming are the major threats to Kerala mangroves.

Keywords: True mangroves, Descriptions and illustrations, Mangrove associates, Dwindling populations, Threat to the ecosystem

Introduction

The mangrove vegetation comprises of unique plant communities consisting of evergreen trees and shrubs belonging to several unrelated families growing in tropical and subtropical intertidal regions where there is constant intertidal exchange of sea water and freshwater. The components of the flora exhibit remarkable adaptations for salt tolerance. World over, the mangroves cover 14 million hectares in coastal areas of the tropics.

In India, the total area of mangroves is estimated to be 6740 sq. km (MoEF, 1987), which is about 7% of the world's mangrove area. Indian mangroves can be broadly divided into East Coast deltaic and West Coast non-deltaic (Rao *et al.*, 1999). The extent of mangroves along the East Coast of India is larger than that along the West Coast. A detailed account of mangroves in India was provided by Blasco (1975). Banerjee *et al.* (1989) and Naskar (2004) studied the mangroves in India and provided detailed manuals. Rajpurohit (1989) grouped mangroves of India into 12 flora-element groups and recognized eight mangrove species as endemic to India.

There is hardly any comprehensive account on the mangrove species of Kerala coast other than a few scattered enumerations from various localities.

Ramachandran *et al.* (1986) observed that the mangroves of Kerala were degraded and grew in isolated patches. Chand Basha (1992) stated that the total extent of mangrove area in Kerala was approximately 17 sq. km. Mohanan (1999) estimated it to be "less than 50 sq. km" and listed a total of 32 mangrove species. Probably, this number is inclusive of some of the prominent mangrove associates. Misidentifications of species have also been noted in many of the earlier enumerations. These prompted a detailed study of the mangroves of Kerala coast and the present contribution is the result of such a study that lasted for a period of more than four years (2000-2004).

Kerala state lying in the southwest corner of Peninsular India with a total area of about 38863 sq. km. is situated between 8°18'-12°48' N latitude and 74°52'-77°22' E longitude. Kerala has a narrow coastal line of about 550 km, constituted of a long stretch of backwaters and a series of lagoons running parallel to the sea, estuaries and river deltas. There are 44 rivers originating from the Western Ghats. Climate is humid tropical with an average annual rainfall of about 240 cm. Temperature varies from 20 to 38°C, the pH of mangrove water from 7.4 to 8.1 and salinity from 0 to 25 ppt.

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Systematic Treatment

Bracketed keys for the identification of true mangrove genera are provided. Genera are treated in alphabetic sequence. The genus with more than one species is provided with key to the species. The species under each genus are given in alphabetic order with updated nomenclature, local names if available, name of the family, precise description, phenology of flowering and fruiting, distribution in the world, India and Kerala, uses if any collected from locals and specimens examined. Detailed illustrations of all the species are also provided.

Key to genera

- 1a. Plants with milky sap; flowers unisexual; calyx and corolla indistinct **Excoecaria**
- 1b. Plants without milky sap; flowers bisexual; calyx and corolla distinct. 2
- 2a. Corolla polypetalous 3
- 2b. Corolla gamopetalous 4
- 3a. Plants with vivipary; petals with or without apical cilia and marginal hairs 5
- 3b. Plants without vivipary; petals without apical cilia and marginal hairs 6
- 4a. Leaf margin spiny; anthers bearded **Acanthus**
- 4b. Leaf margin not spiny; anthers not bearded 8
- 5a. Stilt-roots and prop-roots present; calyx lobes 4; petals not bilobed **Rhizophora**
- 5b. Stilt-roots and prop-roots absent; calyx lobes more than 4; petals bilobed 7
- 6a. Leaves opposite; pneumatophores present; stamens numerous; fruit globose, many seeded **Sonneratia**
- 6b. Leaves alternate; pneumatophores absent; stamens ten; fruit ellipsoid, 1 seeded **Lumnitzera**
- 7a. Knee-roots present; calyx lobes 6 or more than 6 **Bruguiera**
- 7b. Knee-roots absent; calyx lobes 5 **Kandelia**
- 8a. Pneumatophores present; leaves silvery white tomentose beneath; corolla yellow **Avicennia**
- 8b. Pneumatophores absent; leaves glabrous beneath; corolla white **Aegiceras**

Acanthus L.

Sp. Pl. 639. 1753.

Acanthus ilicifolius L., Sp. Pl. 639. 1753; Roxb., Fl. Ind. 3 : 32. 1832; C.B. Clarke in Hook. f., Fl. Brit. India 4: 481. 1885; Trimen, Handb. Fl. Ceylon 3: 317. 1895; Parkinson, For. Fl. Andaman Is. 217. 1923; Gamble, Fl. Pres. Madras 1014. 1924; Sant., Bot. Mem. Univ. Bombay 2: 16. 1952; Backer & Bakhuizen, Fl. Java 2: 555. 1965; Mani. & Sivar., Fl. Calicut 221. 1982; Matthew, Ill. Fl. Tamilnadu Carnatic t. 518. 1982; Rani & Matthew in Matthew, Fl. Tamilnadu Carnatic 3: 1146. 1983; Toml., Bot. Mangr. 174. 1986; Naskar & Bakshi, Mangr. Swamp. Sundarbans 80. 1987; Nicols., Suresh & Mani., An Interpr. Hort. Malab. 35. 1988; Ramach. & Nair, Fl. Cannanore 331. 1988; Banerjee *et al.*, Mangr. India 23. 1989; Banerjee & Rao, Mangr. Orissa 89. 1990; Dagar *et al.*, Mangr. Andaman & Nicobar Is. 57. 1991; Mohanan & Henry, Fl. Thiruvananthapuram 342. 1994; Naskar & Mandal, Ecol. & Biodiver. Ind. Mangr. II: 462. 1999. *Dilivaria ilicifolia* (L.) Juss., Gen. Pl. 103. 1789; Pers., Syn. 2 (1) : 179. 1808; Nees in Wallich, Pl. As. Rar. 3 : 98. 1832; Wight, Ic. Pl. Ind. Orient. t. 459. 1846. *Paina-schulli* Rheede, Hort. Malab. 2: 93-94, t. 48. 1679. **Chulli**. [ACANTHACEAE].

Figs 1, 2 a,b.

Gregarious undershrubs, upto 2 m tall, usually erect, rarely scandent, branching infrequently and commonly from older parts; stilt-roots arising from lower portions of stem. *Stem* not woody, terete, glabrous, brownish green; nodes with a pair of spines at the point of insertion of each leaf. *Leaves* opposite-decussate, simple, exstipulate, nearly sessile to petiolate; petiole usually c. 0.5-1 cm and rarely upto c. 2.5 cm long, terete; lamina 7-15 x 6-9 cm, variously shaped as elliptic, ovate-oblong, or ovate-lanceolate, narrowed at base, spinous at apex, glabrous, coriaceous, shiny-green above, pale green beneath; midrib prominent, lateral veins c. 4-12 pairs, lamina sinuately lobed and spinulose along margins, rarely entire. *Inflorescence* terminal or pseudo-axillary bracteate spikes, c. 8-20 cm long; peduncle terete, glabrous. *Flowers* sessile, c. 3.5-4 cm long and 3.5 cm across, zygomorphic; bract 0.6-0.8 x 0.5 cm, ovate, acute, margin ciliate; bracteoles 2, conspicuous, partly covered by the bract, similar to the bract, lanceolate, persistent; calyx green, 4-partite, lobes glabrous, 12-15 mm long and 1 mm broad, shortly connate in two opposite pairs, the outer pair larger; corolla zygomorphic, bluish-violet, c. 3 cm long with a short tube closed by basal hairs; upper lip obsolete, lower lip broadly 3-lobed to entire, recurved by the middle portion; stamens 4, epipetalous, attached to the throat

of corolla tube, didynamous; filaments c. 13-16 mm long, stout, curved, more or less flat; anthers aggregated around the style, c. 1.2 cm long with thick hairy connectives, medifixed, bilobed, one lobe sterile, dehiscing longitudinally; pistil glabrous; ovary

superior, 2-loculed; ovules 2 in each locule on axile placenta; style c. 2.7 cm long, slender, terete, not protruded beyond the stamens; stigma bifid. *Fruit* a capsule, ellipsoid or ovoid-oblong, glabrous, shining, 3-3.5 x 1.3-1.6 cm, apiculate; seeds 4, compressed,

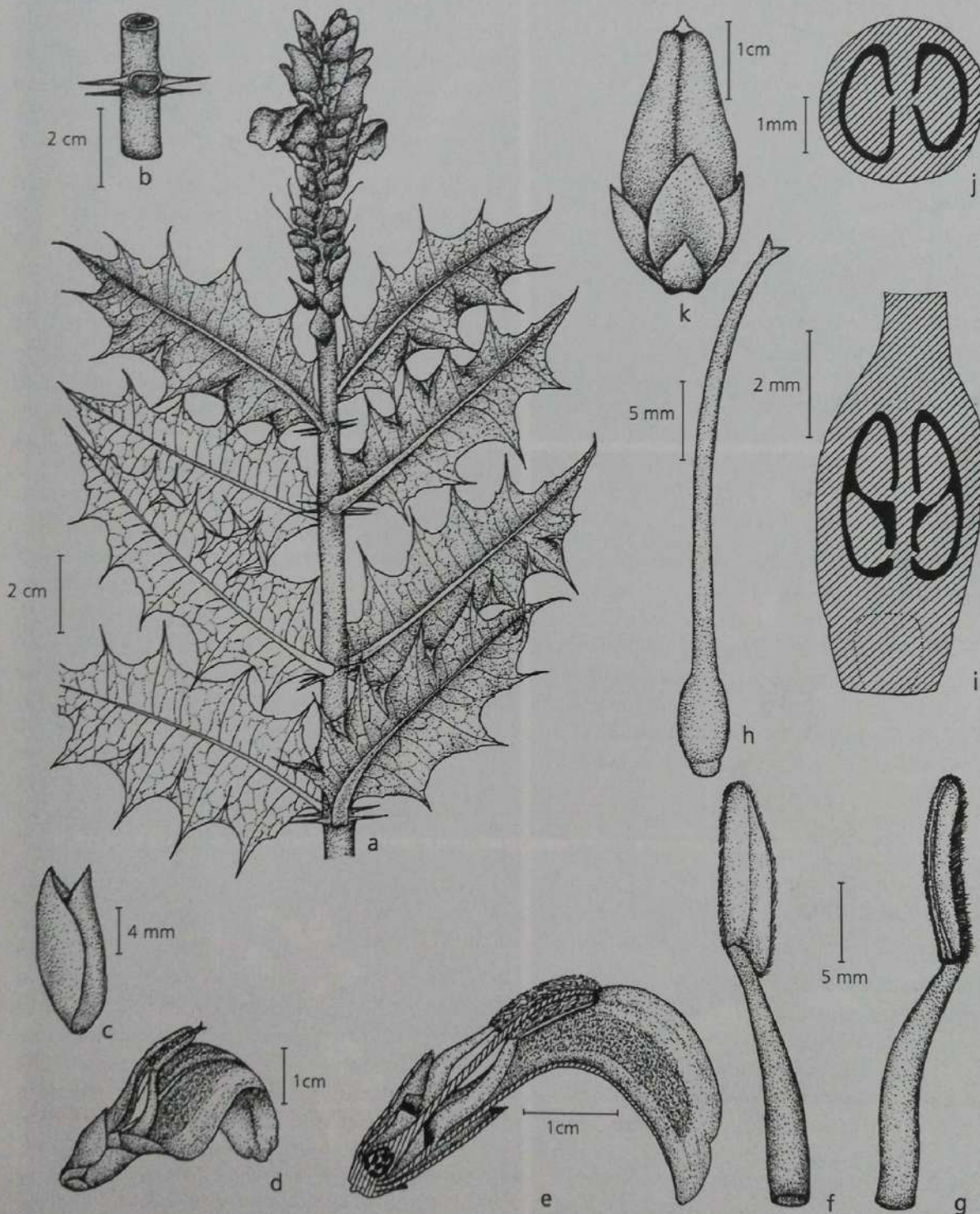


Figure 1. *Acanthus ilicifolius* L. – a. Flowering twig; b. Node with spine pairs; c. Calyx; d. Flower; e. Flower – L.S.; f. Single undehiscent stamen; g. Dehiscent stamen; h. Pistil; i. Ovary – L.S.; j. Ovary – C.S.; k. Fruit.

orbicular, 1.3-1.5 x 1-1.2 cm, supported on short-hooked retinacula; testa lax, often soft and corrugated.

Flowering & Fruiting: March-August.

Distribution: India, Sri Lanka, Australia, Indonesia, Bangladesh, Myanmar, South East Africa, Java and Malaysia. **INDIA:** Throughout along the West Coast and East Coast, and Andaman and Nicobar Islands. **Kerala:** Very common along the entire coastal regions.

Uses: Fruit pulp is used as a blood purifier and leaf-paste in treatment of rheumatism.

Specimens Examined: Thiruvananthapuram Dist.: Veli, 22. 5. 1978, Mohanan 54898 (MH). Kollam Dist.: Parur, 23. 5. 1978, Mohanan 55747 (MH). Kottayam Dist.: Kumarakam, 7. 2. 1987, Fr. Kadavil 1434 (MH). Ernakulam Dist.: Aroor, 20. 4. 1988, Swaminathan 88262 (MH). Thrissur Dist.: Chavakkad, 8. 4. 1977, Ramamurthy 49268 (MH); *Ibid.*, 28. 9. 1982, Ramamurthy 74905 (MH). Kozhikode Dist.: Elathur, 7. 6. 2002, Anupama 81264 (CALI); Kolavipalam, 27. 6. 2002, Anupama 81270 (CALI). Kannur Dist.: Thaliparamba, 18. 2. 1913, Barber 8795 (MH); Thalassery, 15. 6. 1978, Ramachandran 57621 (MH); *Ibid.*, 4. 5. 1979, Ramachandran 62252 (MH). Kasaragode Dist.: Kumbala, 7. 5. 1982, Ansari 71058 (MH).

Note: Remadevi and Binojkumar (2000) have reported *Acanthus ebracteatus* Vahl from Aroor in Alappuzha District. But after careful observation of their specimen (Aroor, 25. 3. 1999, Remadevi 23, Sanatana Dharma College Herbarium, Alappuzha) we found that the specimen did not possess the characteristic features of *Acanthus ebracteatus* Vahl. According to Hooker (1885) the bracteoles are absent in *Acanthus ebracteatus* Vahl, but in the above mentioned specimen bracteoles are present. Therefore, it represents only a variant of *Acanthus ilicifolius* L. with white flowers.

Aegiceras J. Gaertn.

Fruct. 1: 216. 1788.

Aegiceras corniculatum (L.) Blanco, Fl. Filip. 1: 79. 1837 ('*corniculatus*'); Gamble, Fl. Pres. Madras 757. 1921; Backer & Bakhuizen, Fl. Java 2: 196. 1965; Matthew, Ill. Fl. Tamilnadu Carnatic 2: t. 406. 1982; Matthew & Rani in Matthew, Fl. Tamilnadu Carnatic 3: 849. 1983 ('*corniculatus*'); Sald. & Ramesh in Sald., Fl. Karnataka 1: 346. 1984; Toml., Bot. Mangr. 285. 1986; Naskar & Bakshi, Mangr. Swamp. Sundarbans 138. 1987; Bole & Pathak, Fl. Saurashtra 2: 46. 1988; Nicols., Suresh & Mani., An Interpr. Hort. Malab. 191. 1988; Banerjee *et al.*, Mangr. India 62. 1989; Banerjee & Rao, Mangr. Orissa 80. 1990; Dagar *et al.*, Mangr. Andaman & Nicobar Is. 60. 1991; Naskar &

Mandal, Ecol. & Biodiver. Ind. Mangr. II: 450. 1999. *Rhizophora corniculata* L. in Stickm., Herb. Amboin. 13. 1754; L., Amoen. Acad. 4: 123. 1759. *Aegiceras majus* Gaertn., Fruct. Sem. Pl. 1: 216, t. 46, f. 1. 1788, *nom. illeg.* (incl. type of *Rhizophora corniculata* L., 1754); Wight, Ill. Ind. Bot. t. 146. 1850; Beddome, Fl. Sylv. t. 19, f. 3. 1869; C.B. Clarke in Hook.f., Fl. Brit. India 3: 533. 1882; Parkinson, For. Fl. Andaman Is. 195. 1923; Mani. & Sivar., Fl. Calicut 156. 1982. *Aegiceras fragrans* Koenig, Ann. Bot. 1: 129, t. 3. 1805, *nom. illeg.* (incl. type of *Rhizophora corniculata* L., 1754). *Pou-kandel* Rheede, Hort. Malab. 6: 65, t. 36. 1686. **Pookandel.** [MYRSINACEAE]. **Figs 2c,d, 3.**

Large evergreen shrubs, much branched with occasional stilt roots; stem bark smooth, brownish grey; twigs terete, glabrous, reddish green; nodes not conspicuous. **Leaves** alternate, occasionally sub-opposite, simple, exstipulate, petiolate; petiole short, c. 0.5-1 cm long, terete, pale brown; lamina c. 3.5-8.5 x 2-4 cm, elliptic to obovate, cuneate at base, slightly emarginate at apex, margin recurved, glabrous, coriaceous, dark green above, pale green beneath; midrib prominent beneath, lateral veins inconspicuous, c. 10 pairs. **Inflorescence** mostly leaf-opposed umbels, occasionally terminal, many-flowered, peduncle upto c. 0.5 cm long or absent, terete, glabrous. **Flowers** pointed in bud, c. 1.5-2 cm long and c. 0.5-1 cm across, fragrant, bracteate, pedicellate, actinomorphic; bracts minute, ephemeral; pedicel c. 0.8-1 cm long, slender, terete, glabrous with numerous red-coloured resin canals; bracteoles absent; calyx brownish green; sepals 5, fused basally, each c. 5 mm long and c. 3 mm broad, twisted to the left, asymmetric, glabrous, coriaceous with numerous surface-glands, persistent in fruit; corolla gamopetalous, white, thin, petals fused basally to form a tube; corolla tube short, upto c. 4 mm long; corolla lobes 5, each c. 6.5 mm long and c. 2.5 mm broad, broadly ovate, acute, twisted to the left, reflexed at maturity; stamens 5, epipetalous, alternating with the corolla lobes; filaments c. 3 mm long, fused below to form a short tube with a ring of hairs at the level of the mouth of corolla tube; staminal tube fused basally with corolla tube; the outer surface of staminal tube and the inner surface of corolla tube with capitate glands, the density of glands increasing towards the bases of both; anthers c. 4 mm long, medifixed, sagittate, versatile, bilobed and 4-loculed, each locule vertically multilocellate, dehiscing longitudinally; pistil c. 8 mm long, conical, glabrous; ovary unilocular; ovules numerous, embedded in the rounded, apically conical, fleshy, short-stalked free-central placenta; style c. 6 mm long, solid, cylindrical, gradually tapering towards the tip; stigma not



Figure 2. *Acanthus ilicifolius* L. – a. Flower; b. Fruits. *Aegiceras corniculatum* (L.) Blanco – c. Flowers; d. Fruits. *Avicennia marina* (Forssk.) Vierh. – e. Flowers; f. Fruits.

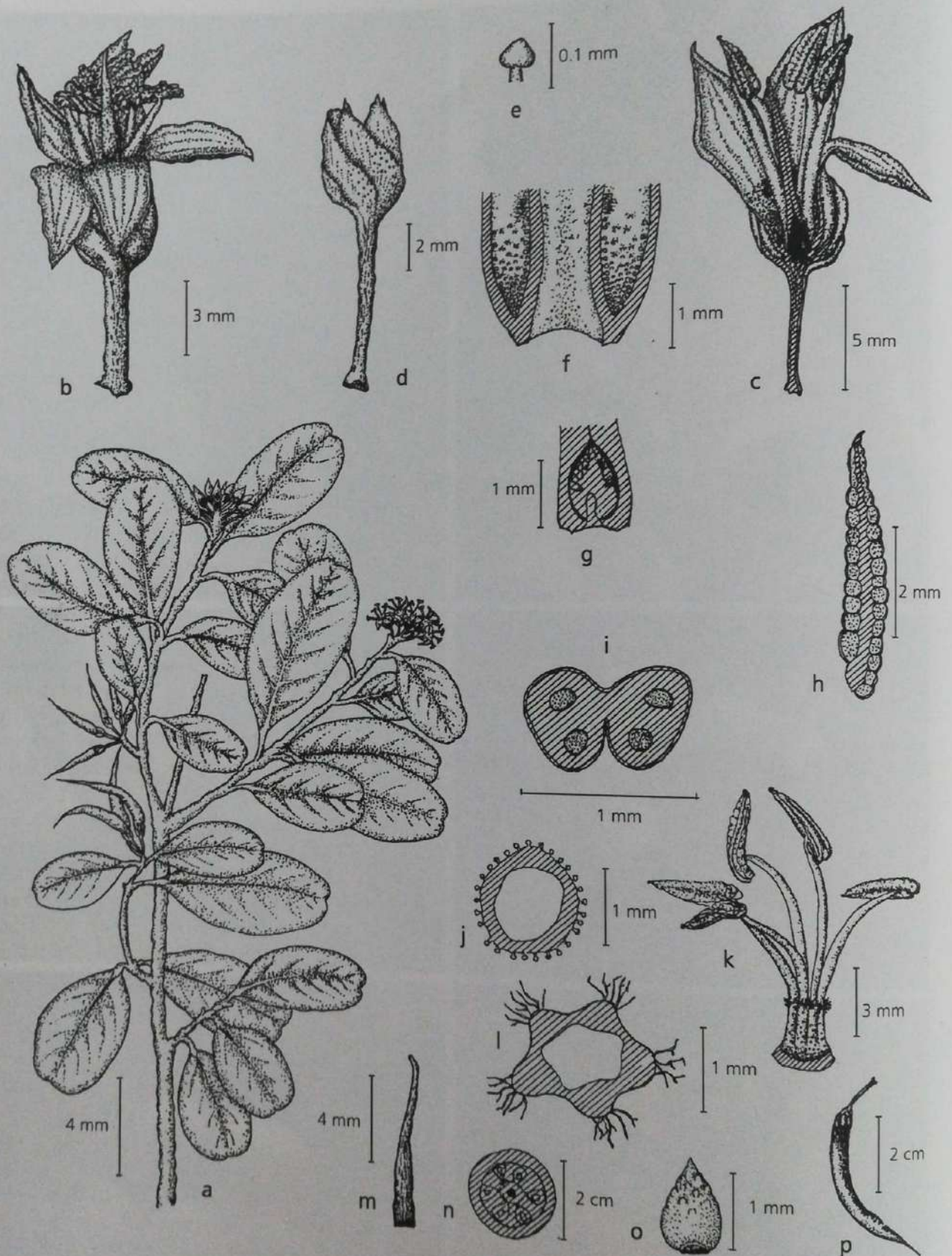


Figure 3. *Aegiceras corniculatum* (L.) Blanco - a. Flowering twig; b. Flower; c. Flower - L.S.; d. Pedicel with calyx; e. Single gland; f. L.S. of the base of corolla with staminal tube showing hairs and glands; g. Ovary - L.S.; h. Anther-lobes - L.S.; i. Anther - C.S.; j. C.S. of the basal portion of the staminal tube; k. Androecium; l. C.S. of the upper portion of the staminal tube; m. Pistil; n. Ovary - C.S.; o. Isolated placenta showing embedded ovules; p. Fruit with persistent calyx.

prominent. *Fruit* a capsule with persistent calyx, cylindric and lunar shaped with sharply pointed apex, c. 5-7.5 cm long, pericarp thin, glabrous; fruit 1-seeded, completely filled at maturity by the embryo; seeds with incipient vivipary.

Note: Mature capsules fall on the ground, split longitudinally along one side and expose the propagule; propagule develops into a young plant within a few days.

Flowering & Fruiting: Throughout the year.

Distribution: Tropical shores from Pakistan through India to Australia; Malaysia, Sri Lanka and South China. INDIA: Along the East Coast and West Coast. Common in Sundarbans. **Kerala:** Kollam, Alappuzha, Thrissur, Malappuram, Kozhikode, Kannur and Kasaragode districts. Common along the Malabar Coast but rare along the Travancore Coast.

Uses: This species is used as firewood. Honey combs found on this plant provide quality honey and bee wax.

Specimens Examined: Kollam Dist: Ayiramthengu, 13. 8. 2004, Anupama 81293 (CALI); Alappuzha Dist.: Kayamkulam, 4. 9. 93, Sunil 1635 (CALI). Ernakulam Dist.: Kumbalam, 31. 12. 1990, Swaminathan 95699 (MH). Thrissur Dist.: Thullikkadu, 11. 2. 1984, Ramamurthy 80484 (MH); Chettuva, 9. 1. 2004, Anupama 81280 (CALI). Kozhikode Dist.: Kadalundi, 17. 4. 1977, Suresh & Manilal 22173 (CALI); Kundupparamba, 1. 2. 2002, Anupama 81209 (CALI); Nadakkavu, 17. 3. 2002, Anupama 81228 (CALI); *Ibid.*, 11. 7. 2002, Anupama 81279 (CALI). Kannur Dist.: Payyannur, 26. 12. 1980, Ansari 70022 (MH); *Ibid.*, 14. 5. 1982, Nair 73877 (MH); Madakkara, 26. 6. 2004, Anupama 81285 (CALI).

Avicennia L.

Sp. Pl. 110.1753.

Key to species

1a. Leaves acute at apex; flowers ca. 6 mm across; fruit c. 2.5 cm long and c. 1.8 cm broad
..... **A. marina**

1b. Leaves obtuse at apex; flowers c. 1.5 cm across; fruit c. 5 cm long and c. 3.5 cm broad
..... **A. officinalis**

Avicennia marina (Forssk.) Vierh., Denkschr. Akad. Wiss. Wien, Math.-Nat. 71: 435. 1907; Gamble, Fl. Pres. Madras 1106. 1924; Alston in Trimen, Handb. Fl. Ceylon 6: 233. 1931; Arulchelvam, Ceylon Forest. Ser. 2, 8: 73, 75. 1978; Moldenke, Phytologia 34: 76-93. 1976; Mani. & Sivar., Fl. Calicut 234. 1982; Matthew & Rani in Matthew, Fl. Tamilnadu Carnatic

3: 1242. 1983; H. N. & A. L. Moldenke in Dassan. & Fosb., Rev. Handb. Fl. Ceylon 4: 127. 1983; Toml., Bot. Mangr. 200. 1986; Naskar & Bakshi, Mangr. Swamp. Sundarbans 97. 1987; Banerjee *et al.*, Mangr. India 36-39. 1989; Banerjee & Rao, Mangr. Orissa 92. 1990; Dagar *et al.*, Mangr. Andaman & Nicobar Is. 58. 1991; Naskar & Mandal, Ecol. & Biodiver. Ind. Mangr. II: 411. 1999. *Sceura marina* Forssk., Fl. Aeg.-Arab. 37. 1775. *Avicennia intermedia* Griff., Trans. Linn. Soc. London, Bot. 20: 6, pl.1. 1846. **Cheru-uppatti, Chakkapoo.** [AVICENNIACEAE]. **Figs 2e,f, 4.**

Shrubs or small trees, very bushy in appearance, evergreen, much branched; radial cable roots producing numerous pneumatophores; pneumatophores growing densely around the tree trunk, straight, pencil-like with more or less pointed tip, upto c. 60 cm long and c. 1.5 cm diameter, whitish brown; stem bark smooth, grey, yellowish white or brown, occasionally flaky; twigs more or less 4-angled, jointed, glabrous, pale brown or brownish green; nodes conspicuous and swollen. *Leaves* simple, exstipulate, shortly petiolate; petiole c. 2-8 mm long, yellowish green with a basal groove, enclosing the apical bud; the basal groove with dark or black marginal hairs; the hairs continuous in a line across the node; lamina c. 1.8-10.2 x 1-5 cm, ovate, lanceolate, narrowly elliptic-oblong or elliptic-ovate, cuneate at base, acute at apex, glabrous above, silvery white tomentose beneath, coriaceous, yellowish green, light to dark green and shiny above; midrib prominent beneath, lateral veins inconspicuous, c. 4-7 pairs. *Inflorescence* terminal or axillary compound spikes; peduncle upto c. 8 cm long, angled, silvery tomentose; flowers decussately arranged in dense capitate units, each with c. 12-16 flowers, younger buds compactly arranged; the units themselves aggregated into terminal or axillary, trichotomously paniculate assemblages on distal shoots; the lower units subtended by the foliage leaves, the upper by reduced, often inrolled leaves. *Flower* c. 5 mm long and c. 6 mm across, fragrant, sessile, slightly zygomorphic; bract small, c. 2 mm long and c. 1.5 mm broad, triangular, convex, brownish green, glabrous within, densely pubescent outside; bracteoles 2, similar to the bract; bract and bracteoles persistent in the fruit; calyx brownish green, sepals slightly united at base; sepals 5, unequal, each upto c. 3 mm long and c. 2 mm broad, triangular, acute, extensively imbricate, thin, glabrous within, densely pubescent outside; calyx persistent in fruit; corolla gamopetalous, yellow, glabrous within, densely silvery pubescent outside, thick, fleshy, petals fused basally to form a tube; corolla tube short, upto c. 1.5

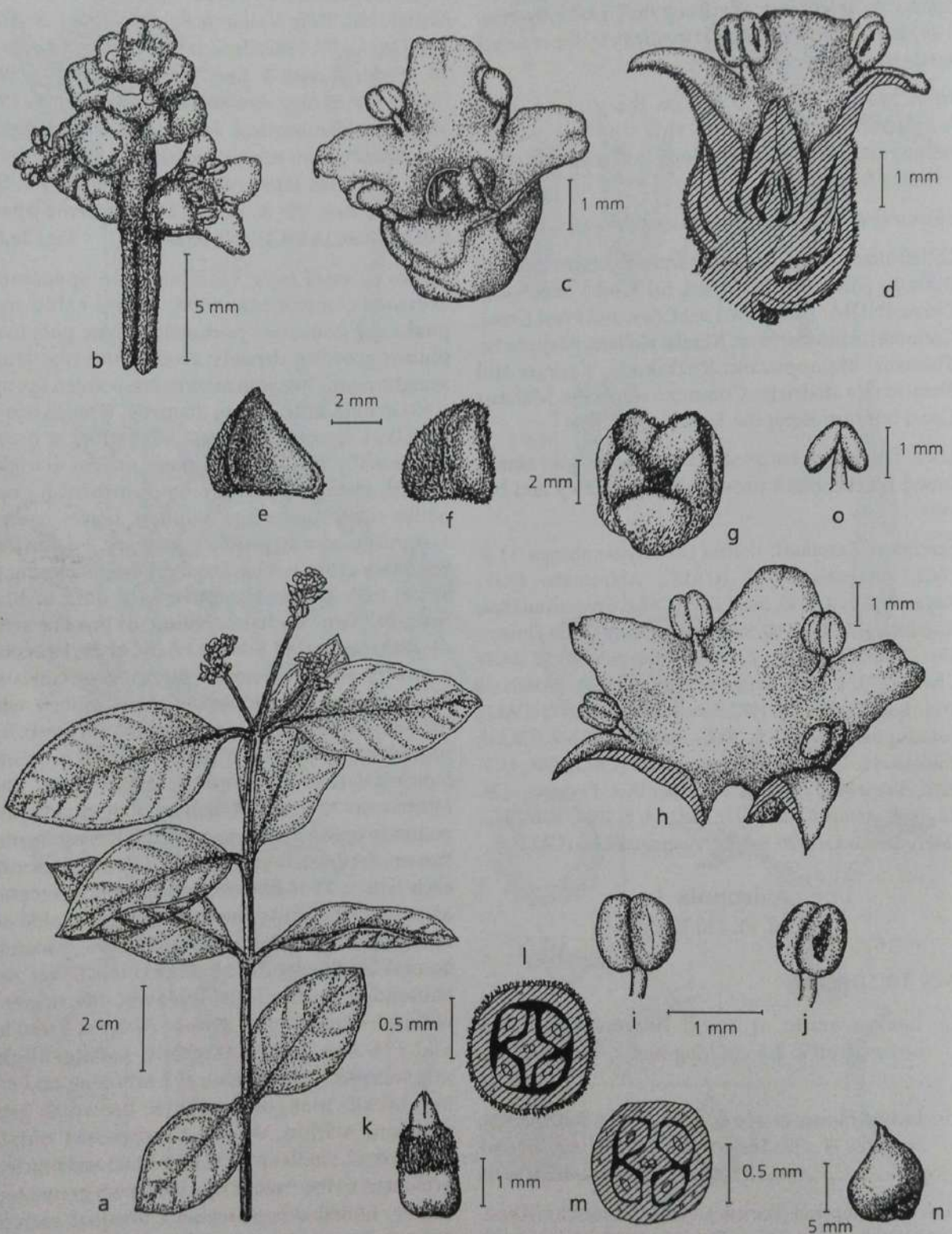


Figure 4. *Avicennia marina* (Forss.) Vierh. - a. Flowering twig; b. A portion of inflorescence; c. Flower; d. Flower - L.S.; e. Bract; f. Bracteole; g. Calyx; h. Corolla split-opened showing stamens; i. Single stamen; j. Dehiscent stamen; k. Pistil; l. Ovary - C.S. through middle portion; m. Ovary - C.S. through basal portion; n. Fruit with persistent bract, bracteoles and calyx; o. Detached placental axis with pendulous ovules.

mm long; corolla-lobes 4, rarely 5, each upto c. 2.5 mm long and c. 2.5 mm broad, elliptic, slightly rounded and curved at apex, imbricate in younger stages, later spreading, reflexed and blackens on maturity; stamens as many as and alternating with corolla lobes, epipetalous, filaments very short, fused basally with corolla; anther c. 1 mm long, basifixed, bilobed, dehiscent longitudinally; pistil c. 2.5 mm long, flask shaped, pubescent only in the middle region; ovary superior, unilocular; ovules 4, pendulous, attached to the tip of the central 4-winged axis, the 4-winged axis arising from the base of the ovary and extending upto the top of the locule and fused with the ovary wall towards the bottom, ovary appearing as 4-loculed; style very short, solid; stigma two lobed. *Fruit* a capsule, more or less rounded, apex pointed with persistent bract, bracteoles, calyx and stylar beak greyish green or yellowish green, upto c. 2.5 cm long and c. 1.8 cm broad; pericarp thick, coriaceous, densely silvery tomentose. *Fruit* 1-seeded, completely filled at maturity by the embryo; seeds with incipient vivipary.

Note: Mature capsules open by two valves releasing the propagule on to the ground; propagule develops into a young plant within a few days.

Flowering & Fruiting: March-July.

Distribution: India, Pakistan, Malaysia, Sumatra, South China, Japan, Sri Lanka, Bangladesh. INDIA: Throughout, including Andaman and Nicobar Islands. Kerala: Kollam, Alappuzha, Kottayam, Ernakulam, Thrissur, Malappuram, Kozhikode, Kannur and Kasaragode districts. Common along the Malabar Coast.

Uses: This species is used as firewood. Leaves are good fodder. Quality honey is obtained from this species.

Specimens Examined: Kollam Dist.: Kollam backwater area, 14. 12. 1980, Mohanan 65038 (MH); *Ibid.*, 16. 12. 1980, Mohanan 65048 (MH). Kozhikode Dist.: Feroke, 10. 3. 1971, Sivarajan 1037 (CALI); Kallai, 29. 3. 77, Suresh 22161 (CALI); *Ibid.*, 12. 4. 2002, Anupama 81240 (CALI); Kolavipalam, 29. 4. 2002, Anupama 81250 (CALI); Mankavu, 16. 6. 2002, Anupama 81267 (CALI); Kannur Dist.: Madakkara, 26. 6. 2004, Anupama 81288 (CALI).

Avicennia officinalis L., Sp. Pl. 110. 1753; C.B. Clarke in Hook. f., Fl. Brit. India 4: 604. 1885; Trimen, Handb. Fl. Ceylon 3: 363. 1895; Parkinson, For. Fl. Andaman Is. 218. 1923; Gamble, Fl. Pres. Madras 1105. 1924; Alston in Trimen, Handb. Fl. Ceylon 6: 233. 1931; Backer & Bakhuizen, Fl. Java 2: 613. 1965; Moldenke,

Phytologia 15: 477-478. 1968, 34: 179-203. 1976; Arulchelvam, Ceylon Forest. Ser. 2, 8: 74, 75, 481. 1978; Mani. & Sivar., Fl. Calicut 234. 1982; Matthew, Ill. Fl. Tamilnadu Carnatic 2: t. 560. 1982; H. N. & A. L. Moldenke in Dassan. & Fosb., Rev. Handb. Fl. Ceylon 4: 132. 1983; Matthew & Rani in Matthew, Fl. Tamilnadu Carnatic 3: 1243. 1983; Toml., Bot. Mangr. 199. 1986; Naskar & Bakshi, Mangr. Swamp. Sundarbans 97. 1987; Nicols., Suresh & Mani., An Interpr. Hort. Malab. 259. 1988; Bole & Pathak, Fl. Saurashtra 2: 195-199. 1988; Ramach. & Nair, Fl. Cannanore 360. 1988; Banerjee *et al.*, Mangr. India 40. 1989; Banerjee & Rao, Mangr. Orissa 92. 1990; Dagar *et al.*, Mangr. Andaman & Nicobar Is. 58. 1991; Mohanan & Henry, Fl. Thiruvananthapuram 363. 1994; Naskar & Mandal, Ecol. & Biodiver. Ind. Mangr. II: 405. 1999. *Avicennia tomentosa* Jacq., Enum. Syst. Pl. 25. 1760; Willd. in L., Sp. Pl. 3 (1): 395. 1800; Wight, Ic. Pl. Ind. Orient. 4 (3): t. 1481. 1849. *Avicennia oepata* Ham., Trans. Linn. Soc. London 17 (2): 221. 1835. *Avicennia officinalis* var. *tomentosa* Cowan, Rec. Bot. Surv. India 11: 199, 220. 1928. *Oepata* Rheede, Hort. Malab. 4: 95-96, t. 45. 1683. Uppatti. [AVICENNIACEAE].

Figs 5, 7a,b.

Medium sized evergreen trees, much branched with occasional stilt-roots; radial cable roots producing pneumatophores; pneumatophores numerous, growing densely around the tree trunk, straight, cylindrical, often forked with blunt tips, c. 10-50 cm long and c. 0.5-2 cm diameter, whitish brown; stem bark smooth, brownish grey or whitish grey; twigs terete, glabrous, pale brown or pale green; nodes conspicuous and swollen. *Leaves* simple, exstipulate, petiolate; petiole c. 1-1.8 cm long, pale green with a deep basal groove, enclosing the apical bud; the basal groove with dark or black marginal hairs; the hairs continuous in a line across the node; lamina c. 5-10.2 x 2.5-5 cm, ovate, broadly elliptic-obovate, cuneate at base, obtuse at apex, glabrous above, silvery-white tomentose beneath, coriaceous, shiny-green above; midrib prominent beneath, lateral veins inconspicuous, c. 7-10 pairs. *Inflorescence* terminal or axillary compound spikes; flowers decussately arranged in dense capitate units, each unit with c. 10-12 flowers, younger buds compactly arranged; the units themselves aggregated into terminal or axillary trichotomously paniculate assemblages on distal shoots; the lower units subtended by the foliage leaves, the upper by reduced leaves; peduncle upto c. 25 cm long, terete, silvery tomentose. *Flowers* upto c. 1 cm long and c. 1.5 cm across, fragrant, sessile, zygomorphic; bract small, c. 3 mm long and c. 3 mm broad, triangular, convex, green, black-tipped with a

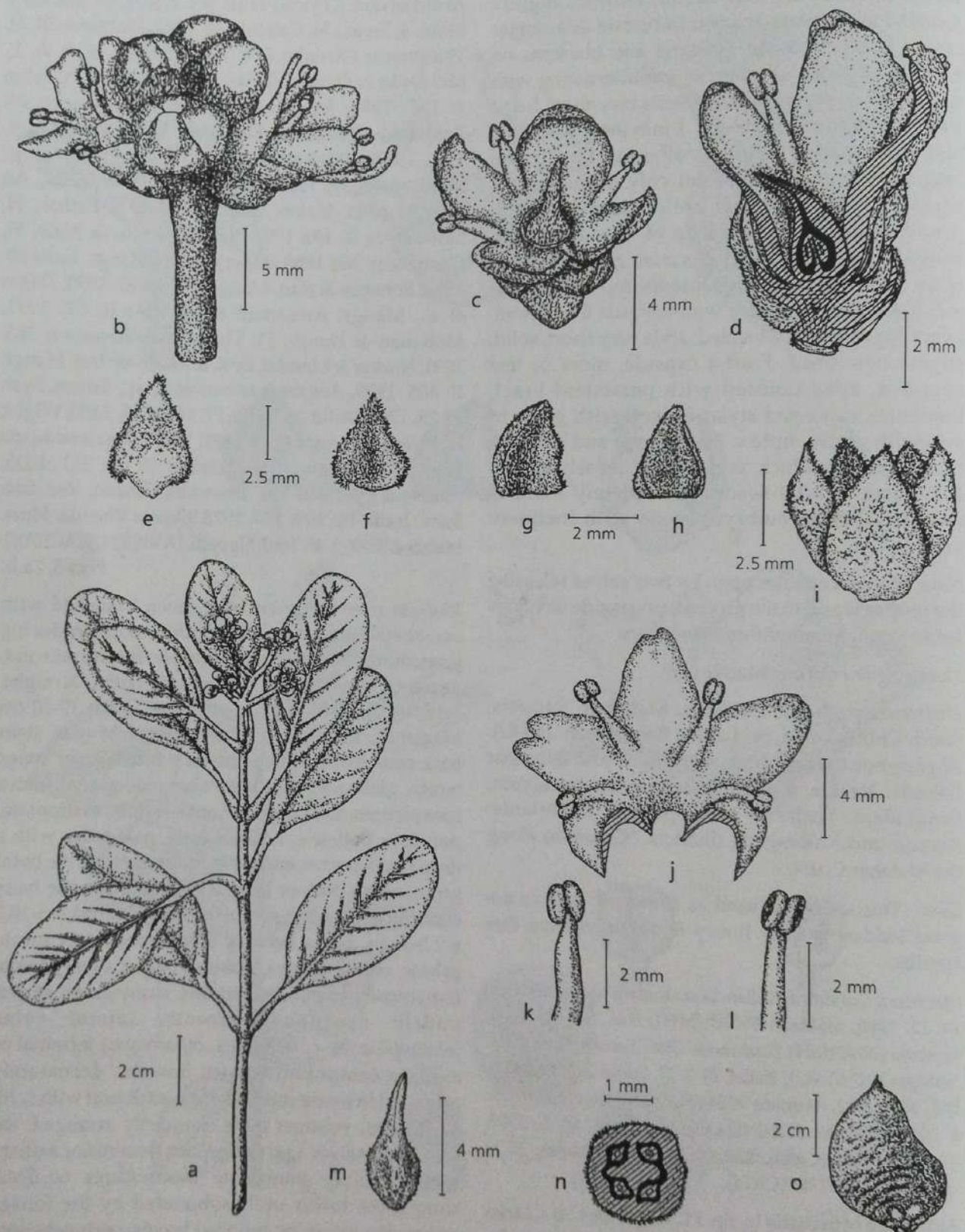


Figure 5. *Avicennia officinalis* L. - a. Flowering twig; b. A portion of inflorescence; c. Flower; d. Flower - L.S.; e. Sepal - dorsal side; f. Sepal - ventral side; g. Bract; h. Bracteole; i. Calyx; j. Corolla tube split-opened showing stamens; k. Single stamen; l. Stamen - after dehiscence; m. Pistil; n. Ovary - C.S.; o. Fruit

fringed margin, glabrous within, densely pubescent on outer surface; bracteoles 2, similar to the bract, slightly smaller than the former; bract and bracteoles persistent in fruit; calyx brownish green, sepals slightly united at base; sepals 5, each upto c. 5 mm

long and c. 4 mm broad, triangular, tip acute, extensively imbricate, thin, glabrous within, pubescent outside; calyx persistent in fruit; corolla yellow, glabrous within, densely pubescent on outer surface, thick, fleshy; petals fused basally to form a

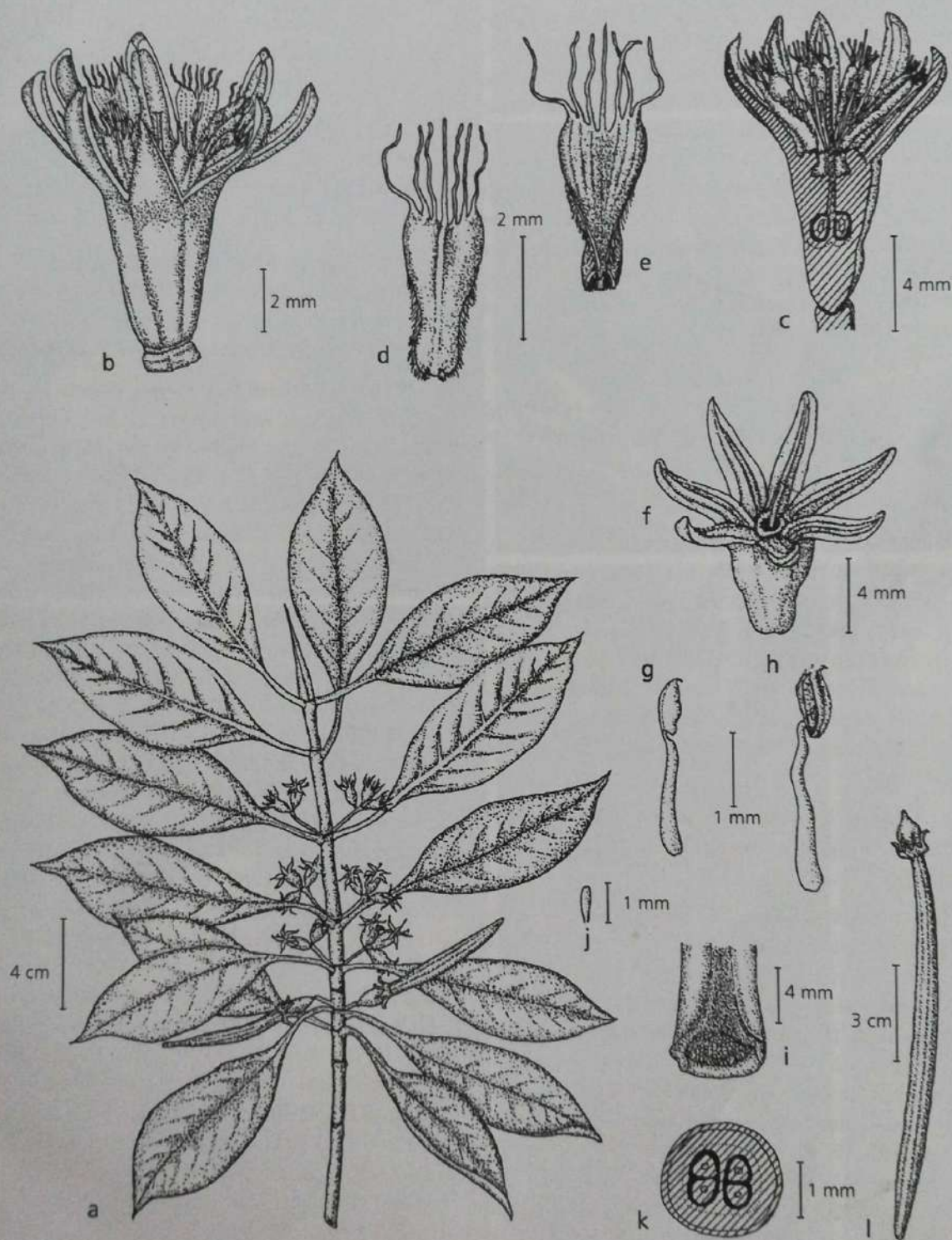


Figure 6. *Bruguiera cylindrica* (L.) BL. - a. Flowering twig; b. Flower; c. Flower - L.S.; d. Petal - dorsal side; e. Petal - ventral side; f. Flower with petals and stamens removed; g. Stamen; h. Stamen - after dehiscence; i. Base of the stipule showing colleters; j. Single colleter; k. L.S. of ovary; l. Viviparous seedling.

tube; corolla tube short, upto c. 4 mm long; corolla lobes 4, unequal, upto c. 6 mm long and c. 5 mm broad, elliptic, slightly rounded and curved at apex, imbricate in younger stages, later spreading, reflexed and blackening on maturity; stamens 4, epipetalous, filaments c. 3 mm long, fused basally with corolla; anther c. 1 mm long, basifixed, bilobed, dehiscing longitudinally; pistil c. 0.65 cm long, flask-shaped, slightly oblique, pubescent; ovary superior, imperfectly unilocular; ovules 4, pendulous, attached to the tip of the central 4-winged axis; style c. 3 mm long, solid, gradually tapering; stigma unequally 2-lobed. *Fruit* with persistent bract, bracteoles and calyx greyish green or yellowish green, mango-shaped, c. 5 cm long and c. 3.5 cm broad, flattened, apex pointed with persistent stylar beak; pericarp thick, coriaceous, densely silvery tomentose; fruit 1-seeded, completely filled at maturity by the embryo; seeds with incipient vivipary.

Note: Capsule opens by two valves releasing propagule on to the ground; young plant develops within a few days.

Flowering & Fruiting: March-July.

Distribution: India, Sri Lanka, Myanmar, Bangladesh, Philippines, Australia, Malaysia, Java, and China. **INDIA:** Throughout along the West Coast and East Coast, and Andaman and Nicobar Islands. **Kerala:** Thiruvananthapuram, Kollam, Alappuzha, Kottayam, Ernakulam, Thrissur, Malappuram, Kozhikode, Kannur and Kasaragode districts. Very common both along the Malabar and Travancore Coasts.

Uses: Timber is used for house building and furniture making. Leaves are used as fodder. Fruits are edible.

Specimens Examined: Kollam Dist.: Kollam backwater, 28. 2. 1979, Mohanan 61230 (MH); *Ibid.*, 13. 2. 1980, Mohanan 65034 (MH). Alappuzha Dist.: Aroor, 7. 5. 93, Sunil 1596 (CALI); *Ibid.*, 14. 8. 2004, Anupama 108302 (CALI). Ernakulam Dist.: Thripunithura, 22. 4. 1988, Swaminathan 88283 (MH); Kumbalam, 31. 12. 1990, Swaminathan 95700 (MH). Kozhikode Dist.: Kadalundi, 5. 5. 72, Erady 2126 (CALI); Kadalundi 8. 9. 78, Suresh & Manilal 21743 (CALI); Kolavipalam, 29. 4. 2002, Anupama 81251 (CALI); Cheruvannur, 17. 5. 2002, Anupama 81259 (CALI); Mankavu, 16. 6. 2002, Anupama 81268 (CALI). Kannur Dist.: Thalassery, 15. 6. 1978, Ramachandran 57622 (MH); *Ibid.*, 4. 5. 1979, Ramachandran 62257 (MH); Payyannur, 25. 9. 1982, Ansari 74304 (MH); Madakkara, 26. 6. 2004, Anupama 81287 (CALI).

Bruguiera Lam.

Tabl. Encycl. Meth. Bot. t. 397. 1793.

Key to species

- 1a. Flowers in cymes, less than 2 cm long; calyx lobes 6-9, completely reflexed in fruit; fruit slender, slightly curved **B. cylindrica**
- 1b. Flowers solitary, 2-3 cm long; calyx lobes 12-16, erect in fruit; fruit stout, not curved **2**
- 2a. Petal margin glabrous or partly hairy; calyx and petiole reddish; calyx tube almost smooth towards the base; viviparous seedlings upto 25 cm long **B. gymnorrhiza**
- 2b. Petal margin densely hairy from base to apex; calyx and petiole never reddish; calyx tube prominently ridged towards the base; viviparous seedlings upto 15 cm long **B. sexangula**

Bruguiera cylindrica (L.) Blume, Enum. Pl. Jav. 1: 93. 1827; Wight & Arn., Prodr. Fl. Ind. Orient. 311. 1834; Miq., Fl. Ind. Bat. I (4): 586. 1856; Naves in Blanco, Fl. Filip. ed. 3, t. 136. 1877-83; Gamble, Fl. Pres. Madras 459. 1919; Watson, Mal. For. Rec. 6: 110, t. 15-16. 1928; Alston in Trimen, Handb. Fl. Ceylon 6: 108. 1931; Holthuis & Lam., Blumea 5: 217. 1942; Ding Hou in van Steenis, Fl. Males. I, 5: 467. 1958; Backer & Bakhuizen, Fl. Java 1: 381. 1963; Arulchelvam, Ceylon Forest. 8: 1969; Mitra & Banerjee, Bull. Bot. Surv. India 21: 142. 1979; Macnae & Fosb. in Dassan. & Fosb., Rev. Handb. Fl. Ceylon 2: 492. 1981; Matthew & Britto in Matthew, Fl. Tamilnadu Carnatic 3: 570. 1983; Toml., Bot. Mangr. 351. 1986; Naskar & Bakshi, Mangr. Swamp. Sundarbans 152. 1987; Nicols., Suresh & Mani., An Interpr. Hort. Malab. 215. 1988; Banerjee *et al.*, Mangr. India 70. 1989; Banerjee & Rao, Mangr. Orissa 63. 1990; Dagar *et al.*, Mangr. Andaman & Nicobar Is. 62. 1991; Naskar & Mandal, Ecol. & Biodiver. Ind. Mangr. II: 388. 1999. *Rhizophora cylindrica* L., Sp. Pl. 443. 1753. *R. caryophylloides* Burm. f., Fl. Ind. 109. 1768. *Bruguiera caryophylloides* Blume, Enum. Pl. Jav. 1: 93. 1827; Arn., Ann. Mag. Nat. Hist. 1: 368. 1838; Miq., Fl. Bat. I (4): 589. 1856; Kurz, For. Fl. Burma 1: 450. 1877; Henslow in Hook. f., Fl. Brit. India 2: 438. 1878; Trimen, Handb. Fl. Ceylon 2: 154. 1894; King, J. Asiat. Soc. Bengal 66(2): 315. 1897. *Bruguiera malabarica* Arn., Ann. Mag. Nat. Hist. 1: 369. 1838; Henslow in Hook. f., Fl. Brit. India 2: 438. 1879. *Karii-kandal*, *Kanil-kandel* Rheede, Hort. Malab. 6: 59, t. 33. 1686. **Kuttikandel**. [RHIZOPHORACEAE].

Figs 6, 7c, d.



Figure 7. *Avicennia officinalis* L. – a. Flowers; b. Fruits. *Bruguiera cylindrica* (L.) Blume – c. Flower; d. Fruits. *Bruguiera gymnorhiza* (L.) Savigny – e. Flower; f. Fruit

Medium sized to tall evergreen trees, much branched, stem base occasionally buttressed; underground cable roots producing numerous knee roots; stem-bark cracked, lenticellate, grayish; twigs terete, glabrous, bronze-coloured, occasionally green; nodes conspicuous with stipular scars; stipular scar narrow, thin, brown, encircling the node; apical bud c. 4.5 cm long. Leaves opposite-decussate, simple, stipulate, petiolate; stipules c. 3.5 cm long, golden yellow, the two stipules overlapping each other, enclosing the apical bud; many densely arranged short clavate glandular colleters present at the base of stipule within; petiole c. 1-3 cm long, terete, bronze-coloured; lamina c. 4-13 x 2-5.5 cm, elliptic or oblanceolate, cuneate at base, acute at apex, glabrous, coriaceous, bronze-green coloured above, pale green beneath; midrib prominent beneath lateral veins inconspicuous, c. 8 pairs. Inflorescence axillary cymes, usually unbranched, 3-flowered, rarely cymes branched with upto 6 flowers; peduncle c. 0.8-1.5 cm long, terete, glabrous. Flowers usually sessile, rarely middle flowers pedicellate, to c. 3 mm long; each flower c. 1.6 cm long and c. 0.9-1.2 cm across; bracts inconspicuous; bracteoles connate to form a very short stubby ring on which the flower rests; calyx greenish white, sepals fused basally to form a prominent calyx tube; calyx tube smooth, glabrous, enclosing the ovary; calyx lobes 6-9, each c. 5 mm long, narrow, thick, fleshy, glabrous, persistent in fruit; petals as many as and alternating with the calyx lobes, free, shortly stalked, white, turning brown after anthesis, each c. 3.5 mm long, apically bilobed, with a long bristle in the sinus of the lobes, lobes equal, tip more or less rounded with 3 or 4 cilia on each, margin densely hairy in the lower half and at the base except the stalk; petals longitudinally folded, enclosing a pair of stamens; stamens double the number of petals, free, but in groups of two, inserted in the folds of each petal; each group of stamens with filaments of unequal length, longer stamens with filaments c. 2.2 mm long and shorter with filaments c. 1.8 mm long; filaments terete; anthers c. 0.5 mm long, mucronate, basifixed, bilobed, dehiscing longitudinally; pistil with ovary semi-inferior, inserted within and fused with the calyx cup, 2-loculed; ovules 2 in each locule, pendulous; style c. 6 mm long, filiform, terete; stigma bifid. Fruit ovoid, c. 1.5 cm long with persistent calyx, reddish green, glabrous, persistent calyx lobes reflexed at maturity; 1-seeded; seed exhibiting vivipary, hypocotyl elongating and piercing the apex of the fruit; viviparous seedling upto c. 16 cm long and c. 6 mm diameter, cylindric, tapering towards the radicle end with blunt tip, slightly curved, surface slightly ridged, green with a brownish tinge; cotyledonary collar not extending.

Note: Mature viviparous seedling falls on the ground and develops into a young plant within a few days.

Flowering & Fruiting: Mostly throughout the year.

Distribution: India, Maldives, Sri Lanka, Australia, Indonesia, Bangladesh, Myanmar, Malaysia, Thailand, and New Guinea. INDIA: Throughout along the West Coast and East Coast, and Andaman and Nicobar Islands. Kerala: Thiruvananthapuram, Kollam, Alappuzha, Ernakulam, Thrissur, Malappuram, Kozhikode and Kannur districts; common along the Malabar Coast but occasional along the Travancore Coast.

Uses: This species produces quality timber and tannin. Viviparous seedlings are edible.

Specimens Examined: Kollam Dist.: Ayiramthengu, 13. 8. 2004, Anupama 81294 (CALI). Alappuzha Dist.: Veeyapuram-Trikunnappuzha, 16. 1. 93, Sunil 1452 (CALI). Ernakulam Dist.: Thripunithura, 22. 4. 1988, Swaminathan 88281 (MH); *Ibid.*, 1. 1. 1991, Swaminathan 95710 (MH); Puthuvypu, 14. 8. 2004, Anupama 81297 (CALI). Thrissur Dist.: Thullikkadu, 11. 2. 1984, Ramamurthy 80486 (MH); Chavakkad, 6. 2. 1984, Ramamurthy 80867 (MH); Chettuva, 9. 1. 2004, Anupama 81282 (CALI). Kozhikode Dist.: Kadalundi, 7. 2. 2002, Anupama 81210 (CALI); Kolavipalam, 26. 3. 2002, Anupama 81231 (CALI); *Ibid.*, 29. 4. 2002, Anupama 81247 (CALI).

Bruguiera gymnorrhiza (L.) Savigny in Lam., Encycl. Meth. Bot. 4: 696. 1798 ('*gymnorhiza*'); Blume, Enum. Pl. Java I: 92. 1827; Wight & Arn., Prodr. Fl. Ind. Orient. 311. 1834; Miq., Fl. Ind. Bat. I (4): 586. 1856; Thw., Enum. Pl. Zeyl. 120. 1859; Kurz, For. Fl. Burma 1: 450. 1877; Henslow in Hook. f., Fl. Brit. India 2: 437. 1879; Trimen, Handb. Fl. Ceylon 2: 153. 1894; King, J. Asiat. Soc. Bengal 66(2): 314. 1898; Parkinson, For. Fl. Andaman Is. 164. 1923; Hochreutiner, Candollea 2: 448. 1925; Watson, Mal. For. Rec. 6: 110, t. 15-16. 1928; Alston in Trimen, Handb. Fl. Ceylon 6: 108. 1931; Ding Hou in van Steenis, Fl. Males. I, 5: 461. 1958; Arulchelvam, Ceylon Forest. 8: 69. 1969; Backer & Bakhuizen, Fl. Java 1: 381. 1963; Mitra & Banerjee, Bull. Bot. Surv. India 21: 142-150. 1979; Macnae & Fosb. in Dassan. & Fosb., Rev. Handb. Fl. Ceylon 2: 493. 1981; Matthew, Ill. Fl. Tamilnadu Carnatic 2: t. 258. 1982; Matthew & Britto in Matthew, Fl. Tamilnadu Carnatic 3: 570. 1983; Toml., Bot. Mangr. 347. 1986; Naskar & Bakshi, Mangr. Swamp. Sundarbans 152. 1987; Nicols., Suresh & Mani., An Interpr. Hort. Malab. 215. 1988; Banerjee *et al.*, Mangr. India 72. 1989; Banerjee & Rao, Mangr. Orissa 58. 1990; Dagar *et al.*, Mangr. Andaman & Nicobar Is. 62. 1991; Mohanan & Henry, Fl. Thiruvananthapuram 180. 1994; Naskar & Mandal, Ecol. & Biodiver. Ind. Mangr. II: 383. 1999. *Rhizophora gymnorrhiza* L., Sp.

Pl. 443. 1753 ('*gymnorhiza*'). *Bruguiera rheedii* Blume, Enum., Pl. Jav. 1: 92. 1827; Wight Icon. Pl. Ind. Orient. t. 239 A, 1-8. 1839 & Ill. Ind. Bot. 210. 1860; Beddome, Fl. Sylv. S. India, Anal. Gen. t. 14, f. 1. 1872. *Bruguiera conjugata* Merr., Philipp. J. Sci. Bot. 9: 118. 1914;

Gamble, Fl. Pres. Madras 458. 1919; Holthuis & Lam., Blumea 5: 217. 1942. *Kandel* Rheede, Hort. Malab. 6: 57-58, t. 31-32. 1686. *Kandel*. [RHIZOPHORACEAE].

Figs 7e,f, 8.

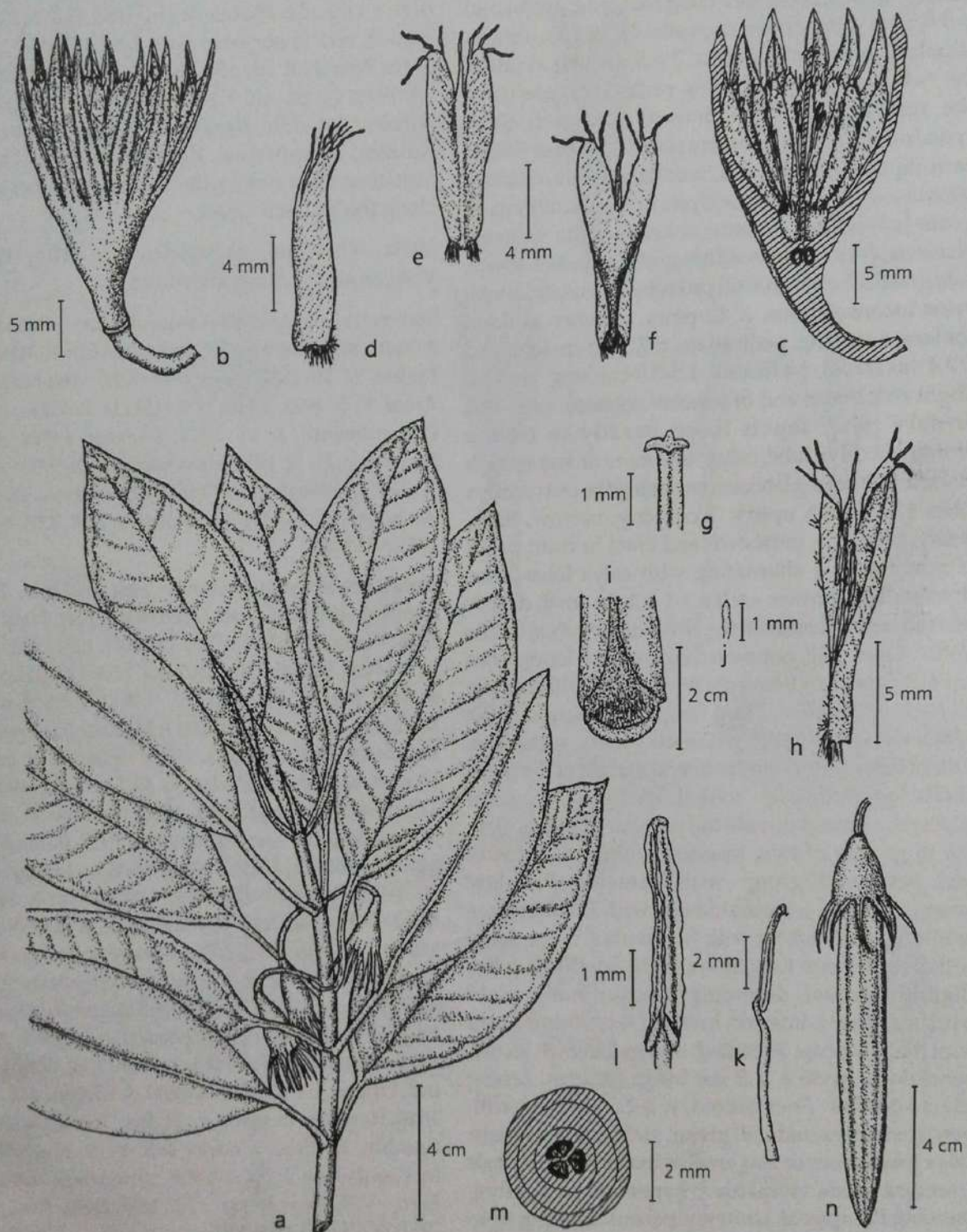


Figure 8. *Bruguiera gymnorhiza* (L.) Savigny - a. Flowering twig; b. Flower; c. Flower - L.S.; d. Petal - side view; e. Petal - dorsal side; f. Petal - ventral side; g. Terminal portion of the style magnified showing stigma; h. Petal with stamens inside; i. Base of the stipule showing colleters; j. Single colleter; k. Single stamen; l. Anther - after dehiscence; m. Ovary - C.S.; n. Viviparous seedling with persistent calyx.

Medium sized to tall evergreen trees, much branched, stem base occasionally buttressed; underground cable roots producing numerous knee roots; stem bark roughly fissured, lenticellate, greyish to black; twigs terete, glabrous, reddish green, occasionally green; nodes conspicuous with stipular scars; stipular scar narrow, thin, brown, encircling the node; apical bud c. 3-4.5 cm long. *Leaves* opposite-decussate, simple, stipulate, petiolate; stipules c. 3-5.5 cm long, reddish, the two stipules overlapping each other, enclosing the apical bud; many densely arranged short cylindric glandular colleters present at base within each stipule; petiole c. 2-4.5 cm long, terete, reddish; lamina c. 6-14 x 3-5.5 cm, elliptic to elliptic oblong, or ovate-lanceolate, cuneate at base, acute at apex, glabrous, coriaceous, reddish-green coloured above, pale green beneath; midrib prominent beneath, lateral veins inconspicuous, c. 12 pairs. *Flowers* axillary, solitary, drooping, pedicellate, c. 2.5-3.5 cm long and c. 2.4 cm across; pedicels c. 1.5-2.5 cm long, curved, bright red; bracts and bracteoles not seen; calyx red or dark pink, sepals fused basally to form a prominent calyx tube; calyx tube more or less smooth towards the base, glabrous, enclosing the ovary; calyx lobes 12-16, each upto c. 2 cm long, narrow, thick, fleshy, glabrous, persistent and erect in fruit; petals as many as and alternating with calyx lobes, free, short stalked, brown, each c. 1.1-1.3 cm long, deeply bilobed with a bristle in the sinus of the lobes; bristle upto c. 4 mm long, not exceeding the petal lobes; lobes equal, tip more or less acute or rounded with 2-4 cilia on each; cilia upto c. 2 mm long; basal margin of the petals with dense, stiff, white silky hairs, sometimes tufts of hairs seen along the lateral margin of the petal; petals longitudinally folded, enclosing a pair of stamens; stamens double the number of petals, free, but in groups of two, inserted within the folds of each petal; each group with filaments of slightly unequal length, longer stamens with filaments c. 6 mm long, and shorter with filaments c. 5 mm long; anthers c. 4-5 mm long, mucronate, basifixed, lobes slightly unequal, dehiscing longitudinally; pistil with ovary semi-inferior, inserted within and fused with the calyx cup, 3-loculed; ovules 2 in each locule, pendulous; style c. 1.5 cm long, filiform, terete; stigma 3-4-fid. *Fruit* conoid, c. 2-2.5 cm long with persistent calyx, reddish green, glabrous, persistent calyx lobes more or less erect at maturity; each fruit 1-seeded; seeds viviparous; hypocotyl elongating, piercing the apex of fruit; viviparous seedling upto c. 10-25 cm long and c. 1.2 cm diam., cylindric, cigar shaped with blunt tip, surface slightly ridged, green with a brownish tinge; cotyledonary collar not extending.

Note: Mature viviparous seedling falls on the ground and develops into a young plant within a few days.

Flowering & Fruiting: Mostly throughout the year.

Distribution: India, Sri Lanka, Malaysia, Madagascar, Micronesia, Polynesia, Australia, Tropical South East Africa and the shores of the Red Sea to Ryukyu Islands, and to northern New South Wales and east to the Marshall Islands. **INDIA:** Throughout along the West Coast and East Coast, and Andaman and Nicobar Islands. **Kerala:** Thiruvananthapuram, Kollam, Alappuzha, Ernakulam and Thrissur districts; common along the Travancore Coast but rare along the Malabar Coast.

Uses: This species produces quality timber. Viviparous seedlings are edible.

Specimens Examined: Thiruvananthapuram Dist.: Veli, 12. 3. 1978, Suresh & Manilal 21685 (CALI). Kollam Dist.: Kollam, 26. 10. 1904, Barber 6692 (MH). Alappuzha Dist.: Aroor, 7. 5. 1993, Sunil 1595 (CALI). Ernakulam Dist.: Ochanthuruth, 8. 11. 1991, Dhruvan 44024 (CALI); Kumbalam, 31. 12. 1990, Swaminathan 95698 (MH); *Ibid.*, 31. 12. 1990, Swaminathan 95701 (MH); Puthuvypu, 14. 8. 2004, Anupama 81298 (CALI); Kumbalangi, 14. 8. 2004, Anupama 108306 (CALI).

Bruguiera sexangula (Lour.) Poir. in Lam., *Encycl. Suppl.* 4: 262. 1816; Arn., *Ann. Mag. Nat. Hist.* 1: 369. 1838; Watson, *Mal. For. Rec.* 6: 109, t. 11a. 1928; Alston in Trimen, *Handb. Fl. Ceylon* 6: 108. 1931; Ding Hou in van Steenis, *Fl. Males.* I, 5: 463. 1958; Backer & Bakhuizen, *Fl. Java* 1: 381. 1963; Mitra & Banerjee, *Bull. Bot. Surv. India* 21: 148. 1979; Macnae & Fosb. in Dassan. & Fosb., *Rev. Handb. Fl. Ceylon* 2: 493. 1981; Toml., *Bot. Mangr.* 349. 1986; Naskar & Bakshi, *Mangr. Swamp. Sundarbans* 154. 1987; Banerjee *et al.*, *Mangr. India* 76. 1989; Banerjee & Rao, *Mangr. Orissa* 60. 1990; Dagar *et al.*, *Mangr. Andaman & Nicobar Is.* 63. 1991; Naskar & Mandal, *Ecol. & Biodiver. Ind. Mangr.* II: 386. 1999. *Rhizophora sexangula* Lour., *Fl. Cochinch.* 297. 1790. *Bruguiera sexangularis* Spreng., *Syst. Veg.* 2: 602. 1825. *Rizophora polyandra* Blanco, *Fl. Filip.* 396. 1837. *Bruguiera eriopetala* Wight & Arn. ex Arn., *Ann. Mag. Nat. Hist.* 1: 368. 1838; Wight, *lc. Pl. Ind. Orient.* 1: t. 239B, 1-3. 1839, & *Ill. Ind. Bot.* 1: 210. 1840; Henslow in Hook. f., *Fl. Brit. India* 2: 438. 1879; Gamble, *Fl. Pres. Madras* 458. 1919; Hochreutiner in Candollea 2: 449. 1925. *Bruguiera malabarica* Fern.- Vill., *Nov. Appl.* 79. 1880 (non Arn., 1838). [RHIZOPHORACEAE].

Figs 9, 10a,b.

Medium sized to tall evergreen trees, much branched, stem base occasionally buttressed; sometimes with stilt-roots, underground cable roots producing

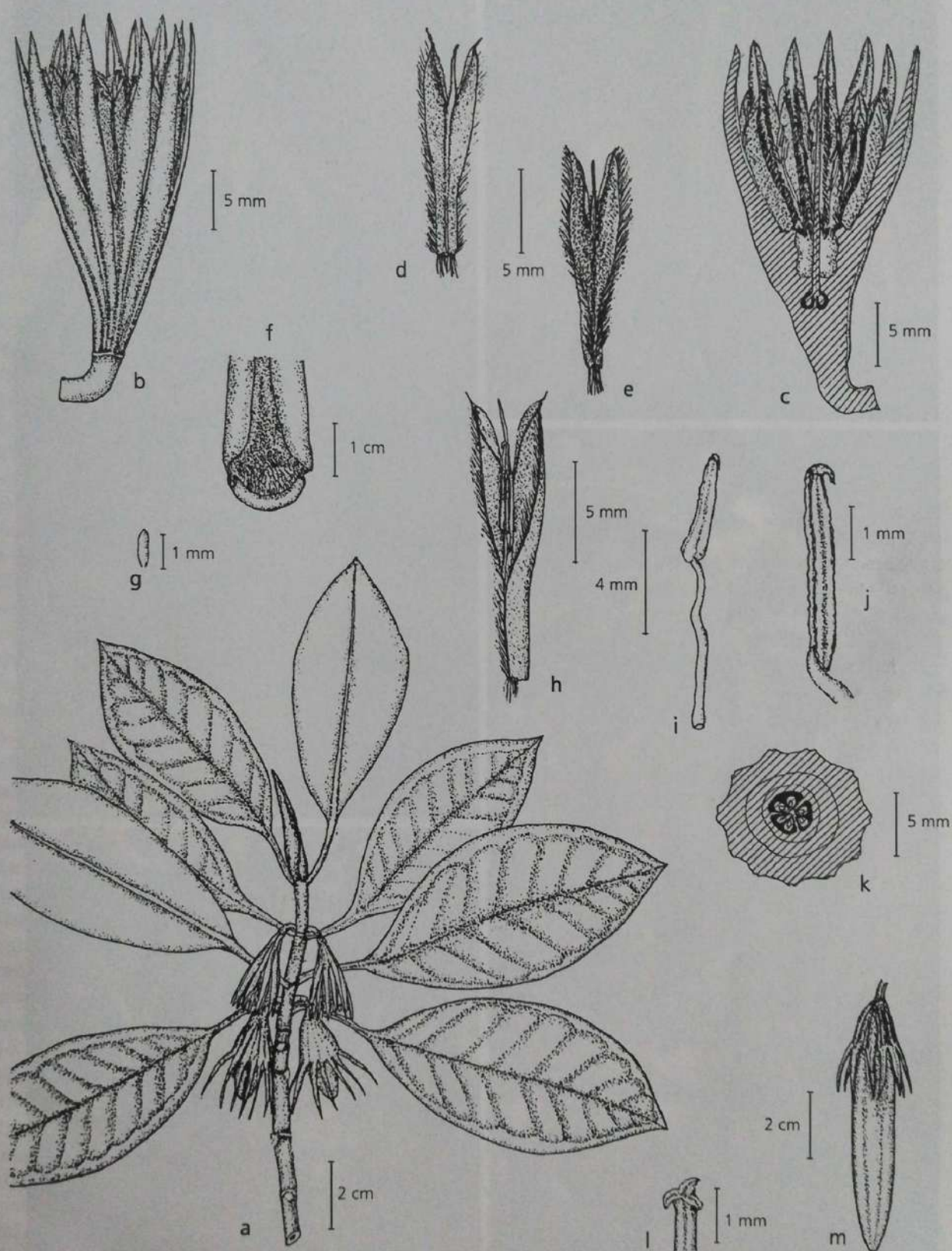


Figure 9. *Bruguiera sexangula* (Lour.) Poir. - a. Flowering twig; b. Flower; c. Flower - L.S.; d. Petal - dorsal side; e. Petal - ventral side; f. Base of the stipule showing colleters; g. Single colleter; h. Petal with stamens inside; i. Single stamen; j. Anther after dehiscence; k. Ovary - C.S.; l. Terminal portion of the style magnified showing stigma; m. Viviparous seedling with persistent calyx.



Figure 10. *Bruguiera sexangula* (Lour.) Poir. – a. Flowers; b. Fruit. *Excoecaria agallocha* L. – c. Flowering twig; d. Fruits.

numerous knee roots; stem bark with a few large corky lenticels, grayish to pale brown; twigs terete, glabrous, reddish green, occasionally green; nodes conspicuous with stipular scars; stipular scar narrow, thin, brown, encircling the node; apical bud c. 4 cm long. *Leaves* opposite-decussate, simple, stipulate, petiolate; stipules c. 3-4 cm long, green or yellowish, the two stipules overlapping each other, enclosing the apical bud; many densely arranged short subcylindric glandular colleters present at the base within each stipule; petiole c. 1.8-3.5 cm long, terete, orange-yellow in colour; lamina c. 8-13 x 4-6 cm, elliptic to elliptic oblong or ovate-lanceolate, cuneate at base, acute at apex, glabrous, coriaceous, reddish-green coloured above, pale green beneath; midrib prominent beneath, lateral veins inconspicuous, c. 10 pairs. *Flowers* axillary, solitary, drooping, pedicellate, c. 2.5-3.5 cm long, c. 2.6 cm across; pedicels c. 6-12 mm long, yellow or brownish, not reddish; bracts and bracteoles not seen; calyx yellow, orange-yellow, yellowish-brown or reddish, but never bright red, sepals fused basally to form a prominent calyx tube; calyx tube ribbed to the base, glabrous; calyx lobes 10-14, each upto c. 1.8 cm long, narrow, thick, fleshy, glabrous, persistent and more or less erect in fruit; petals as many as and alternating with the calyx lobes, free, short stalked, white when young, changing to golden yellow and eventually to brown, each c. 1.5 cm long, deeply bilobed with a bristle in the sinus of the lobes, bristle upto c. 4 mm long, not exceeding the petal lobes; both lobes equal, tip acute with vestiges of 1-3 cilia on each, which are upto c. 1 mm long; outer margin of the petal fringed from the base to the apex with dense, stiff, white, silky hairs; petals longitudinally folded, enclosing a pair of stamens; stamens double the number of petals, free, but in groups of two, inserted within the folds of each petal; each group with filaments of slightly unequal length, longer stamens with filaments c. 6 mm long and shorter with filaments c. 5 mm long; anthers c. 4-5 mm long, mucronate, basifixed, lobes slightly unequal, dehiscing longitudinally; pistil with ovary semi-inferior, inserted within and fused with the calyx cup, 3-loculed; ovules usually 2 in each locule, pendulous; style c. 1.5 cm long, filiform, terete; stigma 3-4-fid. *Fruit* conoid, c. 2-2.5 cm long with persistent calyx, reddish green, glabrous; persistent calyx lobes erect at maturity; 1-seeded; seeds viviparous; hypocotyl elongating and piercing the apex of the fruit; viviparous seedling upto c. 10-15 cm long and c. 1.2 cm diameter, cylindric, cigar shaped with blunt tip, surface slightly ridged, pale green; cotyledonary collar not extending.

Note: Mature viviparous seedling falls on the ground and develops into a young plant within a few days.

Flowering & Fruiting: July-December.

Distribution: South East Asia, India, Sri Lanka, Malaysia, Australia, and New Guinea. **INDIA:** Throughout along the West Coast and East Coast, and Andaman and Nicobar Islands. **Kerala:** Collected only from Ernakulam District; very rare.

Uses: This species produces quality timber. Viviparous seedlings are edible.

Specimens Examined: Ernakulam Dist.: 'Puthuvypu' (Puduvypin), 9. 9. 1990, Dhruvan 48086 (CALI); Panangad, 12. 7. 2004, Ittoop 81291 (CALI); *Ibid.*, 14. 8. 2004, Anupama 108303 (CALI).

Excoecaria L.

Syst. Nat. ed. 10, 2: 1288. 1759

Key to species

- 1a. Plants dioecious; leaf-margin entire or sinuately crenate; fruits trigonous, c. 1-1.5 cm across **E. agallocha**
- 1b. Plants monoecious; leaf-margin regularly crenate; fruits globose, c. 3.5 cm across **E. indica**

Excoecaria agallocha L., Syst. Nat. ed. 10, 2: 1288. 1759, & Sp. Pl. ed. 2, 1451. 1763; Wight, Icon. Pl. Ind. Orient. t. 1865 B. 1852; Hook. f., Fl. Brit. India 5: 472. 1885; Parkinson, For. Fl. Andaman Is. 242. 1923; Gamble, Fl. Pres. Madras 1344. 1925; Backer & Bakhuizen, Fl. Java 1: 499. 1963; Airy Shaw, Kew Bull. 26: 268. 1972, & Euphorb. Borneo 112. 1975 & Kew Bull. 36: 297. 1981; Mani. & Sivar., Fl. Calicut 270. 1982; Matthew, Ill. Fl. Tamilnadu Carnatic 2: t. 638. 1982; Rani in Matthew, Fl. Tamilnadu Carnatic 3: 1442. 1983; Toml., Bot. Mangr. 238. 1986; Naskar & Bakshi, Mangr. Swamp. Sundarbans 112. 1987; Ramach. & Nair, Fl. Cannanore 417. 1988; Nicols., Suresh & Mani., An Interpr. Hort. Malab. 111. 1988; Banerjee *et al.*, Mangr. India 49. 1989; Banerjee & Rao, Mangr. Orissa 98. 1990; Dagar *et al.*, Mangr. Andaman & Nicobar Is. 59. 1991; Chakrab. & Gangop., J. Econ. Taxon. Bot. 18 (1): 198. 1994; Mohanan & Henry, Fl. Thiruvananthapuram 416. 1994; Naskar & Mandal, Ecol. & Biodiver. Ind. Mangr. II: 446. 1999. *Excoecaria camettia* Willd., Sp. Pl. 4: 864. 1806. *Excoecaria agallocha* var. *camettia* (Willd.) Mull.-Arg. in DC., Prodr. 15 (2): 1221. 1866. *Cammetti* Rheede, Hort. Malab. 5: 89-90, t. 45. 1685. **Kannampotti, Kammetti.** [EUPHORBIACEAE].

Figs 10c,d, 11.

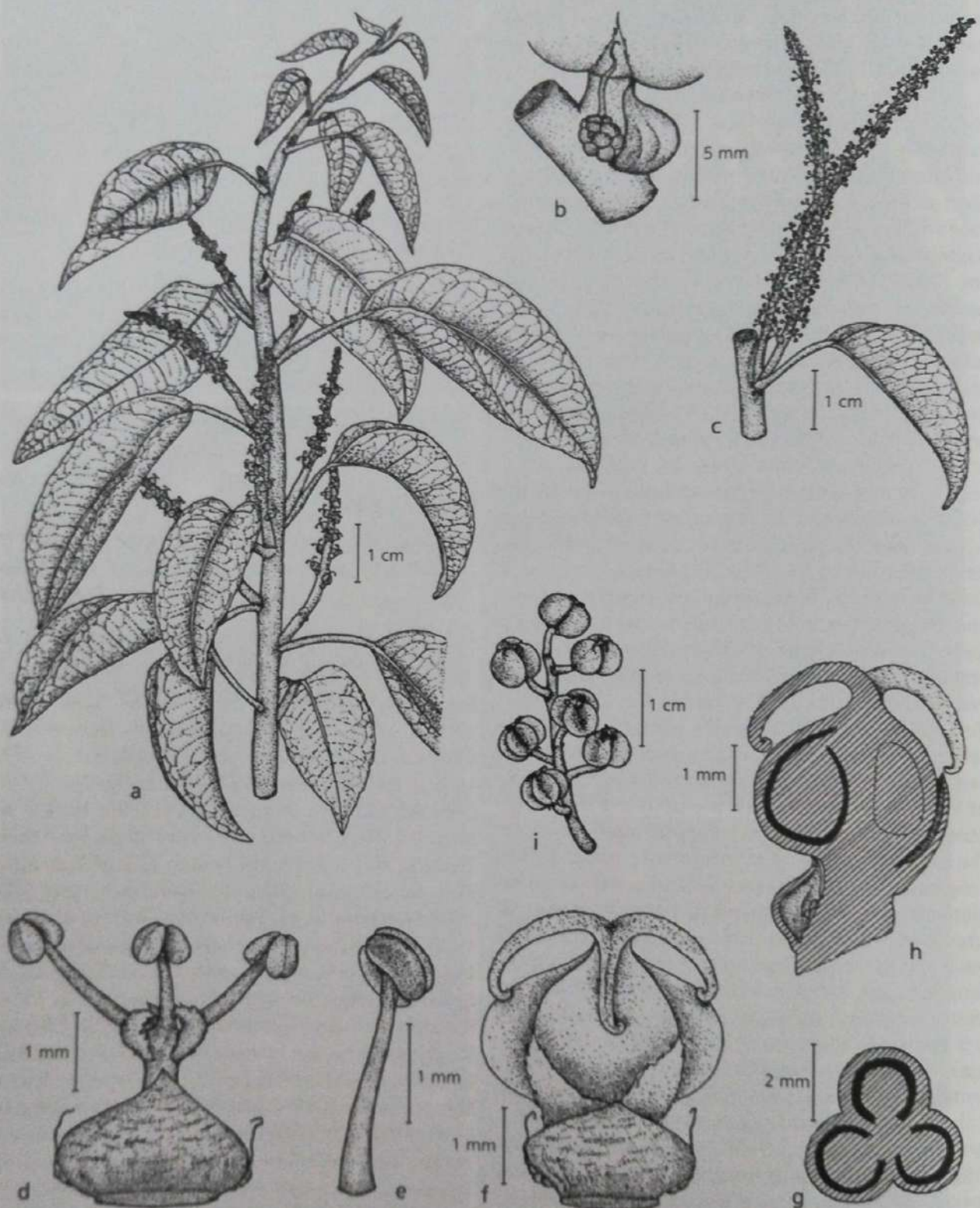


Figure 11. *Excoecaria agallocha* L. - a. Flowering twig of female plant; b. A portion of the female inflorescence showing bracteole with glands, basal portion of a flower and the subtending bract; c. Single node of the male plant with 2 male spikes and the subtending leaf; d. Male flower; e. Single stamen; f. Female flower; g. Ovary - C.S.; h. Female flower - L.S.; i. Infructescence.

Medium sized evergreen trees, dioecious, much-branched with milky acrid latex, sometimes branched from the base, hence shrubby with a bushy appearance; bases of mature trunks with gall-like tumorous outgrowths; a prominent main root absent, many superficial lateral roots spreading and intermingling and exposed during low tides; stem bark smooth, lenticellate, greyish or pale brown; twigs terete, glabrous, brownish green, occasionally green. *Leaves* alternate, spirally arranged, simple, stipulate, petiolate; stipules minute as lateral triangular scales on each side of the petiole, ephemeral; petiole c. 1-2 cm long, terete, green; lamina c. 4-9 x 1.8-6 cm, ovate, ovate-elliptic or ovate-oblong, cuneate or obtuse and with a pair of glands at base, bluntly acuminate at apex, margin entire or sinuate-crenate, glabrous, coriaceous, shiny-green coloured above, turning red before shedding, pale green beneath; midrib prominent beneath, lateral veins c. 8-14 pairs. *Inflorescence* unisexual, axillary, pale green, initiated as catkin like structures within the leaf bearing portion of the shoot, sometimes flowers opening after the falling of subtending leaf. *Male spikes* 5-11 cm long, 2-3 together in an axil with a series of spirally arranged bracts; each bract subtending 1 male flower; one bracteole each present on either side of the flower; bracteoles narrow, laciniate with large glands on either side; male flowers almost sessile, cream-coloured; tepals 3, narrow, c. 1.5 x 1 mm, laciniate; stamens 3, yellow; filaments free, upto 2 mm long; anthers c. 0.5 mm long, basifixed to almost versatile, bilobed, dehiscing longitudinally; pistillode absent. *Female inflorescence* a raceme, usually shorter than the male inflorescence, 4-8 cm long, 1-2 in each axil; female flowers shortly pedicellate, pedicel to c. 3 mm in fruit; bracteate; each flower with a pair of basal bracteoles; bracteoles narrow, laciniate with large glands on either side; tepals 3, c. 1.5 x 1 mm, laciniate, closely adpressed to the ovary; staminodes absent; pistil tricarpeal, syncarpous, glabrous; ovary superior, 3-loculed; ovules 1 in each locule, pendulous; styles 3, simple, stout, spreading, recurved; stigma 3, glandular. *Fruit* depressed globose, 3-lobed, c. 1-1.5 cm across, pericarp smooth, glabrous, dark brown when ripe, fruit dehiscing into 3 cocci separating from a columella to release the seeds; seeds 3, one in each locule, sub-globose or trigonous, about 3 mm in diameter, black; germination epigeal.

Flowering & Fruiting: April-October.

Distribution: India, Sri Lanka, Australia, Bangladesh, Myanmar, North Australia, New Caledonia, Ryukyu Islands and throughout the Pacific Islands. INDIA:

Throughout along the West Coast and East Coast, and Andaman and Nicobar Islands. **Kerala**: Common in most of the mangrove areas.

Uses: This species is used in soft wood industry. Roots are used for making cork.

Specimens Examined: Thiruvnanthapuram Dist.: Chirayinkil, 16. 5. 1979, Mohanan 61812 (MH). Kollam Dist.: Nadayara, 16. 12. 1979, Mohanan 63774 (MH); Ayiramthengu 13. 8. 2004, Anupama 81295 (CALI). Alappuzha Dist.: Thanneermukkam, 29. 12. 1990, Swaminathan 95648 (MH); Veeyapuram, 16. 1. 93, Sunil 1451 (CALI). Ernakulam Dist.: Thripunithura, 1. 1. 1991, Swaminathan 95709 (MH); Ibid., 1. 1. 1991, Swaminathan 95711 (MH). Thrissur Dist.: Chavakkad, 6. 2. 1984, Ramamurthy 80869 (MH). Kozhikode Dist.: Kadalundi, 10. 3. 2002, Anupama 81224 (CALI). Kannur Dist.: Thaliparamba, 20. 2. 1913, Barber 8800 (MH); Thalassery, 21. 2. 1978, Ramachandran 54123 (MH); Payyannur, 26. 12. 1980, Ansari 70026 (MH). Kasaragode Dist.: Kumbala, 25. 1. 1979, Nair 59883 (MH); Ibid., 25. 1. 1979, Ramachandran 59230 (MH); Ibid., 14. 1. 1979, Ansari 59883 (MH).

Excoecaria indica (Willd.) Muell.-Arg., *Linnaea* 32: 123. 1863; Airy Shaw, *Kew Bull.* 36: 297. 1981; Toml., *Bot. Mangr.* 242. 1986; Nicols., Suresh & Mani., *An Interpr. Hort. Malab.* 111. 1988; Chakrab. & Gangop., *J. Econ. Taxon. Bot.* 18 (1): 206. 1998; *Sapium indicum* Willd., *Sp. Pl.* 4: 572. 1805; Wight, *Fl. Ind. Orient.* t. 1950. 1853; Hook. f., *Fl. Brit. India* 5: 471. 1885; Gamble, *Fl. Pres. Madras* 1346. 1925; Naskar & Bakshi, *Mangr. Swamp. Sundarbans* 113. 1987; Choudhury & Acharya, *J. Econ. Taxon. Bot.* 14 (3): 583. 1990. *Bengiri Rheede*, *Hort. Malab.* 4: 105-106, t. 51. 1683. [EUPHORBIACEAE].

Fig. 12.

Medium sized evergreen trees, monoecious, much branched with milky acrid latex; stem bark smooth, lenticellate, greyish or pale brown; twigs terete, glabrous, brownish green, occasionally green. *Leaves* alternate, spirally arranged, simple, stipulate, petiolate; stipules minute; petiole c. 1-1.5 cm long, terete, green; lamina c. 5-12 x 1.5-3 cm, lanceolate, cuneate at base, acute at apex, regularly crenate, glabrous, coriaceous, shiny-green coloured above, pale green beneath; midrib prominent beneath, lateral veins numerous. *Inflorescence* terminal or lateral raceme, pale green, upto 10 cm long with a series of spirally arranged bracts; bracts subtending 5-7 male flowers and large glands on either side. *Female flowers*: 1-2 at base; pedicels upto 4 cm long, slender; tepals 3, connate, 1-1.5 x 1.4-2 mm, imbricate; ovary 3-loculed; ovule 1 in each locule, pendulous; styles 3, simple, spreading, recurved; stigma linear, glandular. *Male flowers*:

above the females subtended by bracts; each bract with large glands on either side and subtending 5-7 flowers; flowers within a bract, maturing at different times; bracteoles narrow, laciniate,

tomentellose; each flower pedicellate, pedicel c. 2 mm long, terete; perianth imperfectly 3-lobed, lobes lacinate; stamens 2 or 3, yellow; filament upto 0.8 mm long, sometimes united below into a column;

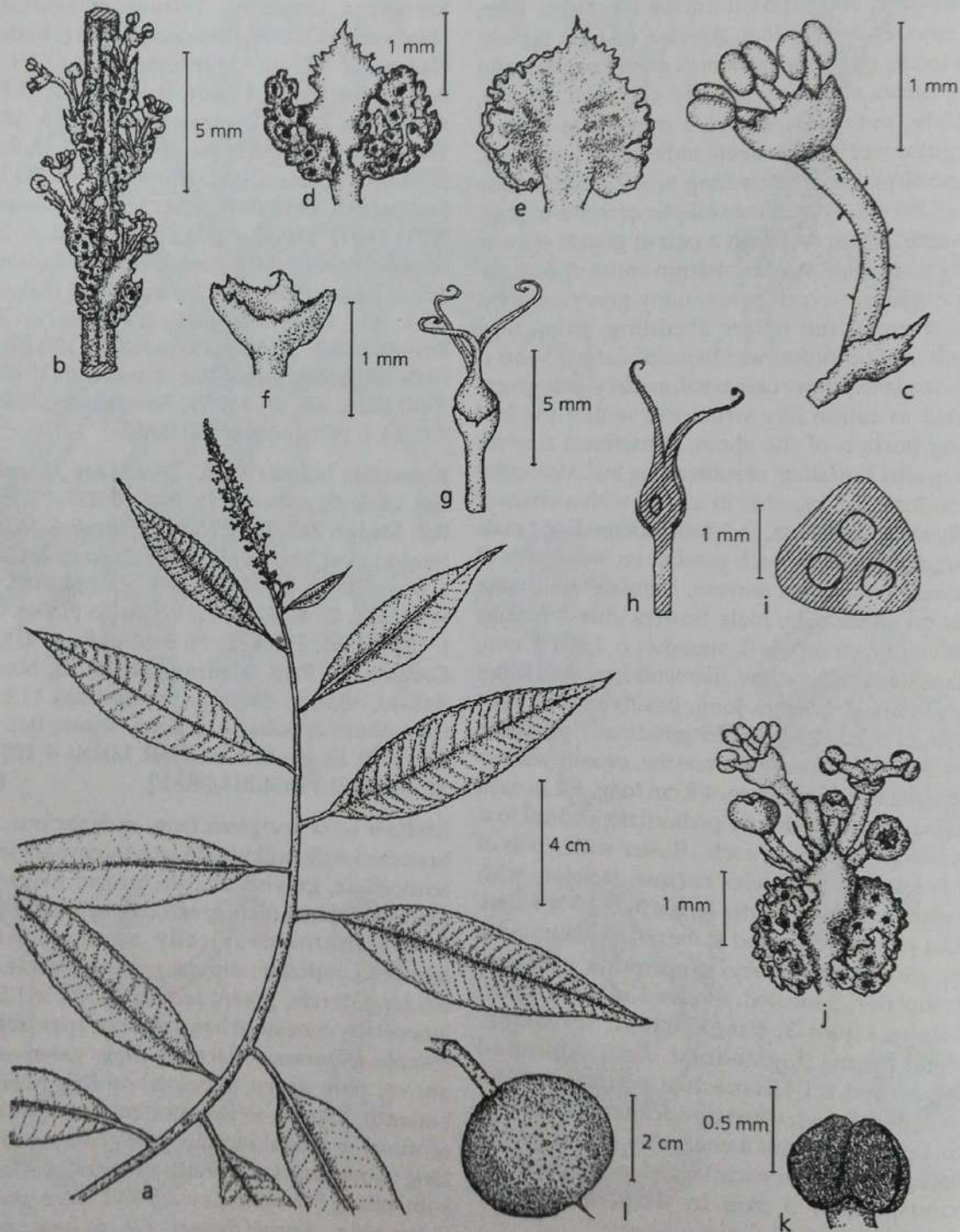


Figure 12. *Excoecaria indica* (Willd.) Muell.-Arg. - a. Twig with inflorescence; b. A part of male portion of the inflorescence; c. Male flower; d. Bract - dorsal side showing glands on either side; e. Bract - ventral side; f. Connate tepals; g. Female flower; h. Female flower - L.S.; i. Ovary - C.S.; j. Single bract and male flowers; k. A dehiscent anther; l. Fruit.

anthers c. 0.5 mm long, basifixed to almost versatile, bilobed, dehiscent longitudinally; pistillodes absent. Capsule 2.5-3.5 cm across, globose, 3-celled, black when dry; seeds 12-4 x 5-7

mm, oblong-ovoid, dark brown.

Flowering & Fruiting: December-March.

Distribution: India, South East Asia, throughout

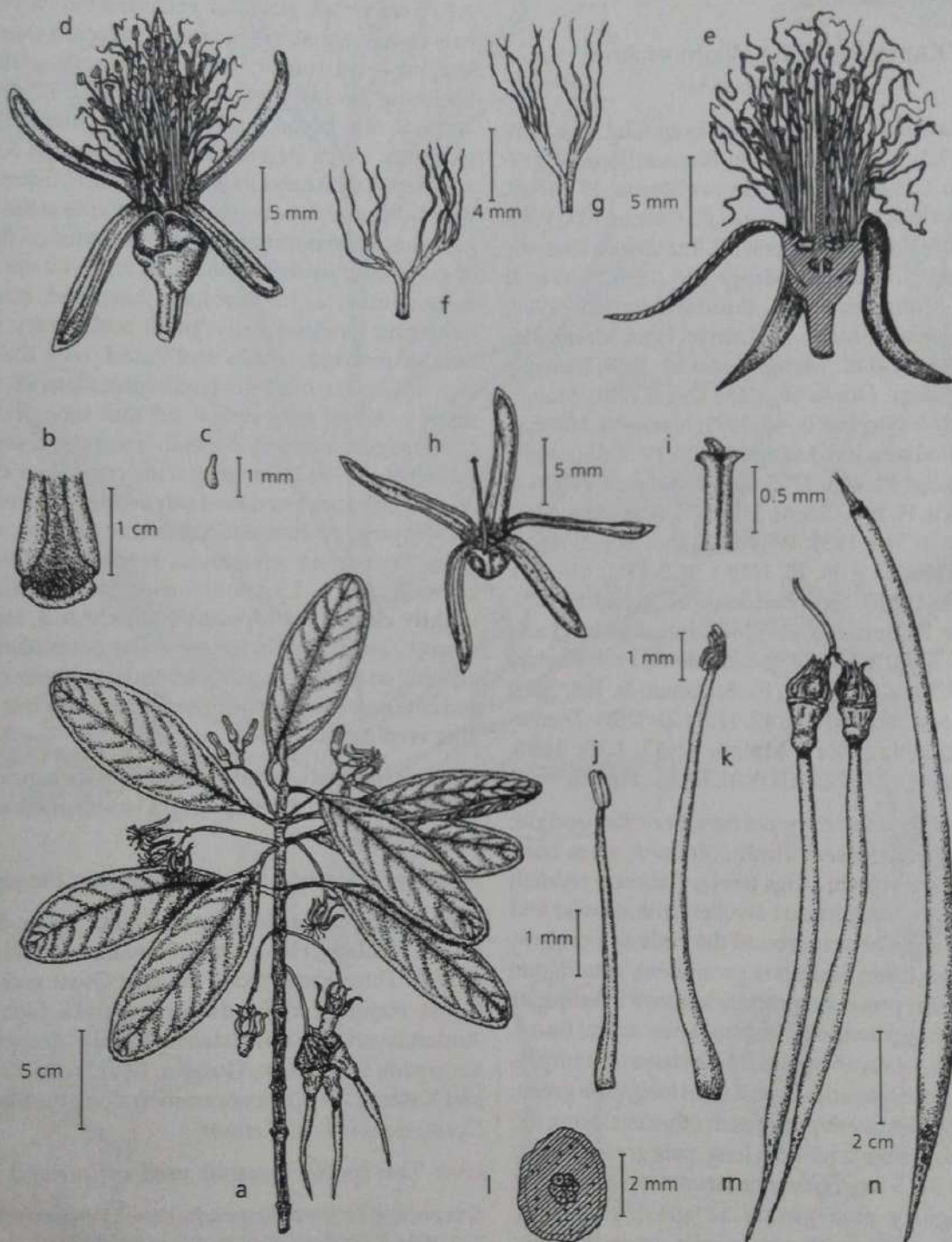


Figure 13. *Kandelia candel* (L.) Druce - a. Flowering twig; b. Base of the stipule showing colleters; c. Single colleter; d. Flower; e. Flower - L.S.; f. Petal - ventral side; g. Petal - dorsal side; h. Flower with petals and stamens removed; i. Terminal portion of the style magnified showing stigma; j. Stamen; k. A dehiscent stamen; l. Ovary - C.S.; m. Viviparous seedlings with persistent calyx; n. Viviparous seedling - detached on maturity.

Malaysia to Solomon Islands. INDIA: Kerala coast and Sundarbans. **Kerala:** Alappuzha and Ernakulam districts; very rare.

Specimens Examined: Alappuzha Dist.: Thrikkunnappuzha, Sunil 1780 (CALI). Ernakulam Dist.: N. Paravoor, 23.5.2004, Kiran Raj 81283 (CALI).

Kandelia (DC.) Wight et Arn.

Prodr. 310. 1834.

Kandelia candel (L.) Druce, Bot. Exch. Club. Soc. Brit. Isles 1913(3): 420. 1914; Slooten, Blumea, Suppl. 1: 169-170, map 3. 1937; Ding Hou in van Steenis, Fl. Males. I, 5: 473. 1958; Mani. & Sivar., Fl. Calicut 103. 1982; Matthew & Britto in Matthew, Fl. Tamilnadu Carnatic 3: 572. 1983; Toml., Bot. Mangr. 360. 1986; Naskar & Bakshi, Mangr. Swamp. Sundarbans 159. 1987; Nicols., Suresh & Mani., An Interpr. Hort. Malab. 216. 1988; Banerjee *et al.*, Mangr. India 81. 1989; Banerjee & Rao, Mangr. Orissa 66. 1990; Dagar *et al.*, Mangr. Andaman & Nicobar Is. 64. 1991; Naskar & Mandal, Ecol. & Biodiver. Ind. Mangr. II: 400. 1999. *Rhizophora candel* L., Sp. Pl. 443. 1753. *Kandelia rheedii* Wight & Arn., Prodr. Fl. Ind. Orient. 311. 1834; Arn., Ann. Mag. Nat. Hist. 1: 365. 1838; Wight, Ill. Ind. Bot. 1: 209, t. 89. 1840; Hook., Icon. Pl. 1(4): t. 362. 1841; Miq., Fl. Ind. Bat. 1 (4): 585. 1856; Beddome, Fl. Sylv. 100. 1871; Kurz, For. Fl. Burma 1: 449. 1877; Henslow in Hook. f., Fl. Brit. India 2: 437. 1879; Gamble, Fl. Pres. Madras 457. 1919; Parkinson, For. Fl. Andaman Is. 165. 1923; Watson, Mal. For. Rec. 6: 49, 113, t.21. 1928. *Tsjeroukandel* Rheedee, Hort. Malab. 6: 63, t.35. 1686. **Nallakandal.** [RHIZOPHORACEAE]. Fig. 13.

Small, much branched evergreen trees, branches upright; stem base buttressed, flesh coloured; stem bark smooth, dark brown; twigs terete, glabrous, reddish brown; nodes conspicuous, swollen with stipular and leaf scars; stipular scar around the node as a narrow, thin, brown layer; leaf scars prominent, round; one peduncle scar present on each side above the stipular scar; leaves clustered at the shoot apex; apical bud c. 3 cm long. *Leaves* opposite-decussate, simple, stipulate, petiolate; stipules c. 2.5 cm long, pale green, the two stipules overlapping each other enclosing the apical bud; petiole c. 1.5-2 cm long, pale green; lamina c. 8.5-12 x 3-4.5 cm, oblong or lanceolate, cuneate at base, slightly emarginate at apex, glabrous, coriaceous, shiny-green above, pale green beneath; midrib prominent beneath, lateral veins inconspicuous, c. 9 pairs. *Inflorescence* axillary cymes, dichotomously branched, 4-flowered; main peduncle upto c. 4.4 cm long, branches upto c. 8 mm long, terete, glabrous; small cupular bracts seen at each

node of the peduncle; 2 flowers arising at the end of peduncular branches. *Flowers* c. 2.2 cm long and c. 3.3 cm across, pedicellate; bracts minute, fused to form a dilated structure at each node on the peduncle; pedicel short, c. 3 mm long, terete, glabrous, ending in bracteoles; bracteoles 2, connate to form a cup of c. 0.35 cm across, glabrous, enclosing the calyx base; calyx white, sepals fused basally to form a short, cup shaped calyx tube; calyx tube smooth, glabrous, enclosing the ovary; calyx lobes 5, each c. 1.5 cm long and c. 2 mm broad, narrowly linear, thick, fleshy, glabrous; calyx persistent in fruit; petals 5, free, alternating with calyx lobes, white, each c. 5 mm long, deeply bilobed; lobes equal with 3-6 cilia at the apex, glabrous; stamens numerous, free, inserted on the rim of calyx cup; filaments unequal, c. 0.7-1.2 cm long, terete; anther c. 1.3 mm long, basifixed, bilobed, dehiscent longitudinally; pistil with ovary semi-inferior, inserted within and fused with the calyx cup, unilocular; ovules 6, pendulous, attached to the tip of a central axis; style c. 0.8 mm long, filiform, terete; stigma minutely 3-lobed. *Fruit* ovoid-conical, 1-seeded, c. 1.5-2 cm long with persistent calyx, brown, glabrous; persistent calyx lobes reflexed and overlapping; peduncle elongated in fruiting stage; seeds viviparous; viviparous seedling upto c. 40 cm long and c. 1.5 cm diameter, spindle shaped, slightly curved with pointed radicle end, surface smooth, green; cotyledonary collar protruded and exposed on maturity, upto c. 0.8 cm long, green, corky, and covering the plumule, persistent on the tree even after seedling fall.

Note: Viviparous seedling at maturity detaches from mother plant and develops into a young plant within a few days.

Flowering & Fruiting: Mostly throughout the year.

Distribution: India, Myanmar, Siam, Japan, South China, Thailand, Hong-Kong, Taiwan, and Malaysia. INDIA: Throughout along the East Coast and West Coast, common in Sundarbans, Orissa, Goa, and Andaman and Nicobar Islands. **Kerala:** Alappuzha, Kottayam, Ernakulam, Thrissur, Kozhikode, Kannur and Kasaragode districts; common along the Malabar Coast, especially in Kannur.

Uses: This species is mainly used as firewood.

Specimens Examined: Alappuzha Dist.: Thanneermukkom, 7. 3. 1993, Sunil 1462 (CALI); Aroor, 14. 8. 2004, Anupama 108301 (CALI). Ernakulam Dist.: Thripunithura, 22. 4. 1988, Swaminathan 88282 (MH). Kozhikode Dist.: Kolavipalam, 26. 3. 2002, Anupama 81233 (CALI); *Ibid.*, 29. 4. 2002, Anupama 81243 (CALI). Kannur Dist.: Payyannur, 14. 5. 1982, Nair 73879 (MH); Madakkara, 26. 6. 2004, Anupama 81284 (CALI).

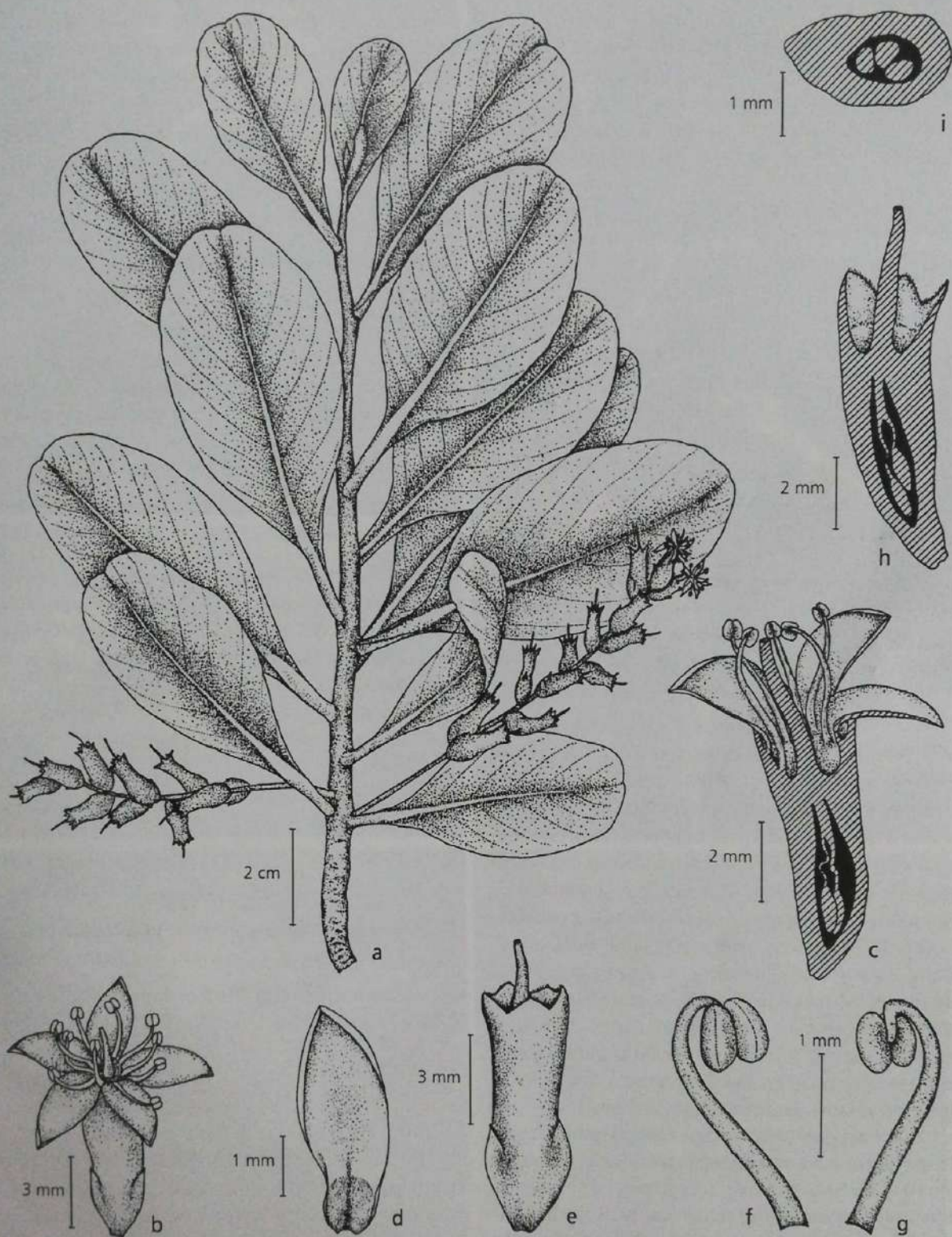


Figure 14. *Lumnitzera racemosa* Willd. – a. Flowering twig; b. Flower; c. Flower – L.S.; d. Petal – ventral side; e. Flower with petals and stamens removed; f. Stamen – dorsal view; g. Stamen – ventral view; h. Pistil – L.S.; i. Ovary – C.S.

Lumnitzera Willd.

Ges. Naturf. Freunde Berlin, Neue Schriften 4: 186. 1803.

Lumnitzera racemosa Willd., Ges. Naturf. Freunde Berlin, Neue Schriften 4: 187. 1803; DC., Prodr. 3: 122. 1828; Wight & Arn., Prodr. Fl. Ind. Orient. 316. 1834; Dalz. & Gibs., Bombay Fl. 90. 1861; Beddome, Fl. Sylv. S. India, Anal. Gen. t.21, f.2. 1869; C. B. Clarke in Hook. f., Fl. Brit. India 2: 452. 1879; Trimen, Handb. Fl. Ceylon 2: 162. 1894; Slooten, Combret. Nederl.-Ind. 28. 1919; Gamble, Fl. Pres. Madras 468. 1919; Parkinson, For. Fl. Andaman Is. 168. 1923; Excell in van Steenis, Fl. Males. I, 4: 588. 1954; Backer & Bakhuizen, Fl. Java 1: 378. 1963; Matthew, III. Fl. Tamilnadu Carnatic 2: t. 264. 1982; Matthew & Britto in Matthew, Fl. Tamilnadu Carnatic 3: 578. 1983; Toml., Bot. Mangr. 225. 1986; Naskar & Bakshi, Mangr. Swamp. Sundarbans 104. 1987; Nicols., Suresh & Mani., An Interpr. Hort. Malab. 85. 1988; Banerjee *et al.*, Mangr. India 46. 1989; Banerjee & Rao, Mangr. Orissa 72. 1990; Dagar *et al.*, Mangr. Andaman & Nicobar Is. 59. 1991; Philcox in Dassan., Fosb. & Clayton, Rev. Handb. Fl. Ceylon 9: 29. 1995; Naskar & Mandal, Ecol. & Biodiver. Ind. Mangr. II: 427. 1999. *Funckia karakandal* Dennst., Schluessel 32. 1818, *nomen*. *Kada-kandel* Rheede, Hort. Malab. 6: 67, t.37. 1686. **Kadakandel**. [COMBRETACEAE]. Figs 14, 15a, b.

Evergreen large shrubs or small trees, much branched, upto 5 m tall; stem base occasionally buttressed; underground cable roots with numerous looping simple, curved roots intermediate between pneumatophores and knee roots; stem bark cracked, lenticellate, brown; twigs terete, glabrous, brownish green. Leaves usually more clustered towards the ends of the branches, alternate, simple, petiolate; petiole c. 0.6-1.5 cm long, terete, pale green; lamina c. 4-10 x 2-5 cm, obovate or oblanceolate, cuneate at base, emarginate at apex, glabrous, thick, coriaceous, entire or minutely crenate, green coloured above, pale green beneath; midrib prominent beneath, lateral veins inconspicuous, c. 10 pairs. Inflorescence lax, axillary spikes, unbranched, many flowered; peduncle upto c. 10 cm long, terete, glabrous. Flowers sessile, c. 10-13 mm long, c. 8 mm across; bracteoles 2, adnate to the base of the calyx tube; sometimes one bracteole adnate to the top of the calyx tube; calyx greenish, sepals fused to form a calyx tube; calyx tube smooth, oblong, enclosing the ovary; calyx lobes 5, small, triangular, acute, persistent, margin ciliate; petals 5, free, alternating with the calyx lobes, oblong, white, each c. 3-4 x 1-1.5 mm, acute; stamens 10 in two

whorls, inner whorl alternating with petals, slightly longer, outer whorl opposite to the petals; filaments terete, curved at apex, c. 2.8 mm long; anthers c. 0.5 mm long, medifixed, versatile, bilobed, dehiscing longitudinally; pistil with ovary semi-inferior, inserted within and fused with the calyx tube, 1-loculed; ovules 2-5, pendulous; style slightly bent apically, c. 3-6 mm long, terete; stigma simple. Fruit ellipsoid, c. 10-12 x 3-5 mm with persistent calyx, laterally compressed, glabrous, crowned with persistent calyx lobes, 1-seeded.

Flowering & Fruiting: June-September.

Distribution: India, Madagascar, Maldives, Sri Lanka, Australia, Indonesia, Bangladesh, Myanmar, Malaysia, Thailand, and New Guinea. **INDIA:** Along the West Coast and the East Coast, and Andaman and Nicobar Islands. **Kerala:** Thiruvananthapuram, Kollam, Alappuzha, and Kannur districts; very rare.

Uses: This species is used as firewood and for extraction of tannin.

Specimens Examined: Thiruvananthapuram Dist.: Veli, 16. 6. 76, Suresh & Manilal 32855 (CALI). Kollam Dist.: Ayiramthengu, 13. 8. 2004, Anupama 81292 (CALI). Alappuzha Dist.: Manjadichira, Kayamkulam, 15. 8. 1995, Sunil 2460 (CALI).

Rhizophora L.

Sp. Pl. 443. 1753

Key to species

- 1a. Peduncle straight; flowers sessile; petal glabrous **R. apiculata**
- 1b. Peduncle pendulous; flowers pedicellate; petals hairy **R. mucronata**

Rhizophora apiculata Blume, Enum. Pl. Jav. 1: 91. 1827; Hochreutiner, Candollea 2: 446. 1925; Alston in Trimen, Handb. Fl. Ceylon 6: 107. 1931; Ding Hou in van Steenis, Fl. Males. I, 5: 452. 1958; Backer & Bakhuizen, Fl. Java 1: 379. 1963; Arulcheluvum, Ceylon For. 8: 65. 1969; Macnae & Fosb. in Dassan. & Fosb., Rev. Handb. Fl. Ceylon 2: 490. 1981; Matthew, III. Fl. Tamilnadu Carnatic 2: t. 968. 1982; Mathew & Britto in Matthew, Fl. Tamilnadu Carnatic 3: 573. 1983; Toml., Bot. Mangr. 336. 1986; Naskar & Bakshi, Mangr. Swamp. Sundarbans 160. 1987; Nicols., Suresh & Mani., An Interpr. Hort. Malab. 216. 1988; Banerjee *et al.*, Mangr. India 82. 1989; Banerjee & Rao, Mangr. Orissa 68. 1990; Dagar *et al.*, Mangr. Andaman



Figure 15. *Lumnitzera racemosa* Willd. – a. Flowers; b. Fruits. *Rhizophora mucronata* Poir. – c. Flowers; d. Fruits. *Sonneratia alba* J. Sm. – e. Flowers; f. Fruits.

& Nicobar Is. 65. 1991; Naskar & Mandal, Ecol. & Biodiver. Ind. Mangr. II: 377. 1999. *Rhizophora candelaria* DC., Prodr. 3: 32. 1828; Wight & Arn., Prodr. Fl. Ind. Orient. 310. 1834; Trimen, Fl. Ceylon 2: 151. 1894; Gamble, Fl. Pres. Madras 456. 1919. *Rhizophora conjugata* sensu Arn., Ann. Mag. Nat. Hist. 1: 363. 1838, non L., 1753; Wight, Ill. Ind. Bot. I. 209. 1840; Miq., Fl. Ind. Bat. 1 (4): 584. 1856; Thw., Enum. Pl. Zeyl. 120. 1859; Kurz, For. Fl. Burma 1: 447. 1877; Henslow in Hook. f., Fl. Brit. India 2: 436. 1879; King, J. Asiat. Soc. Bengal 66 (2): 312. 1897; Parkinson, For. Fl. Andaman Is. 164. 1923; *Pee-kandel* Rheede, Hort. Malab. 6: 61, t. 34. 1686. **Vallikandel**. [RHIZOPHORACEAE]. **Fig. 16.**

Small, evergreen trees, much branched, branches spreading profusely; trunk not conspicuous; trunk and lower branches supported by numerous profusely looping stilt roots and prop roots respectively; roots repeatedly branched, corky, woody, lenticellate, cylindrical, c. 3 m or more long, c. 5-15 cm diameter, brown or greyish white in colour; stem bark fissured, brown; twigs terete, glabrous, reddish brown or greyish white; internodes short towards the shoot apex; nodes conspicuous with stipular scars and leaf scars; stipular scar circular, prominent, scaly, brown; leaf scars prominent, elliptic, c. 4 mm broad. *Leaves* clustered at the shoot apex forming a rosette of leaves; apical bud c. 9 cm long, leaves opposite-decussate, simple, petiolate; stipules c. 9 cm long, c. 1.5 cm broad, narrowing towards the apex, pale red; stipules overlapping and enclosing the apical bud; short densely arranged obclavate colleters present at base within of each stipule; petiole c. 2-3 cm long, pale green; lamina 13-17 x 4-7 cm, elliptic, oblong, oblanceolate or ovate-lanceolate, cuneate at base, apiculate at apex, glabrous, thick, leathery, dark green above, pale green beneath; midrib prominent beneath, lateral veins inconspicuous, numerous. *Inflorescence* axillary cymes, opposite-decussate, unbranched, 2-flowered; peduncle upto c. 0.5 cm long, glabrous. *Flowers* c. 2.2 cm long, c. 1.5 cm across, sessile, bracteate; bracts small, connate; bracteoles 2, connate, copular, c. 5 mm across, thick, woody, surface wrinkled and cracked, dark brown, enclosing the base of calyx; calyx externally fissured, brownish yellow outside and yellowish white and glabrous within; sepals fused basally to form a shallow cup enclosing the basal portion of the pistil; calyx lobes 4, each c. 1.5 cm long, c. 0.7 cm broad, ovate oblong, acute, thick, fleshy; calyx persistent in fruit; petals free, 4, alternating with calyx lobes, white, narrow-lanceolate, acute at apex, each c. 0.9 cm long, c. 2.5

mm broad, thin, flat, glabrous; stamens 11 or 12, free, sessile, inserted on the margin of the receptacular disc; anthers upto c. 8 mm long, multilocellate, many loci irregularly and closely arranged in single layer; dehiscence by a short adaxial valve; anther wall dissociating from the anther during dehiscence, longitudinally recurving and a portion of the wall standing obliquely on the ventral side of the anther; pistil conoid, slightly angled; ovary semi-inferior, inserted within and fused with the calyx cup, 2-loculed; ovules 2 in each locule, pendulous, attached to the apical placenta; style short; stigma bifid. *Fruit* c. 2-4 cm long with persistent calyx, conical; pericarp brown, thick, leathery; persistent calyx lobes reflexed, brown in colour; 1-seeded; seeds viviparous; hypocotyl protruding through the stylar canal, piercing the apex of the fruit; viviparous seedling upto c. 50 cm long and c. 1.8 cm diameter, cylindric, thick towards the radicle tip, tip blunt, more or less straight with a slight curvature at plumular end; surface more or less smooth, green with red dots and streaks; cotyledonary collar protruded and exposed on maturity, upto c. 0.6 cm long, green, corky; persistent on the tree even after seedling fall.

Note: Viviparous seedling develops into a young plant within a few days.

Flowering & Fruiting: Mostly throughout the year.

Distribution: India, Malaysia, Sri Lanka, Bangladesh, Myanmar, New Zealand, E. Africa, and N. Australia. **INDIA:** Along the East Coast and the West Coast; common in the Sundarbans, and Andaman and Nicobar Islands. **Kerala:** Thiruvananthapuram, Kollam, Alappuzha, Kottayam, Ernakulam, Thrissur, Kozhikode, Kannur and Kasaragode districts; occasional.

Uses: This species is used as firewood. Green leaves are used as fodder. Tannin is obtained from bark. Viviparous seedlings are edible.

Specimens Examined: Thiruvananthapuram Dist.: Veli, 12. 2. 79, Suresh & Manilal 32881 (CALI). Kollam Dist.: Ayiramthengu, 13. 8. 2004, Anupama 81296 (CALI). Alappuzha Dist.: Manjadichira-Kayamkulam, Sunil 1748 (CALI). Kozhikode Dist.: Kolavipalam, 13. 2. 2002, Anupama 81215 (CALI); *Ibid.*, 26. 3. 2002, Anupama 81229 (CALI); *Ibid.*, 27. 6. 2002, Anupama 81273 (CALI). Kannur Dist.: Madakkara, 26. 6. 2004, Anupama 81290 (CALI).

Rhizophora mucronata Poir. in Lam., Encycl. Meth. 6:189. 1804; Arn., Ann. Mag. Nat. Hist. 1: 362. 1838; Wight, Ic. Pl. Ind. Orient. 1: 238. 1839 & Ill. Ind. Bot. 209.1840; Miq., Fl. Ind. Bat. I (4): 583. 1856; Thw.,

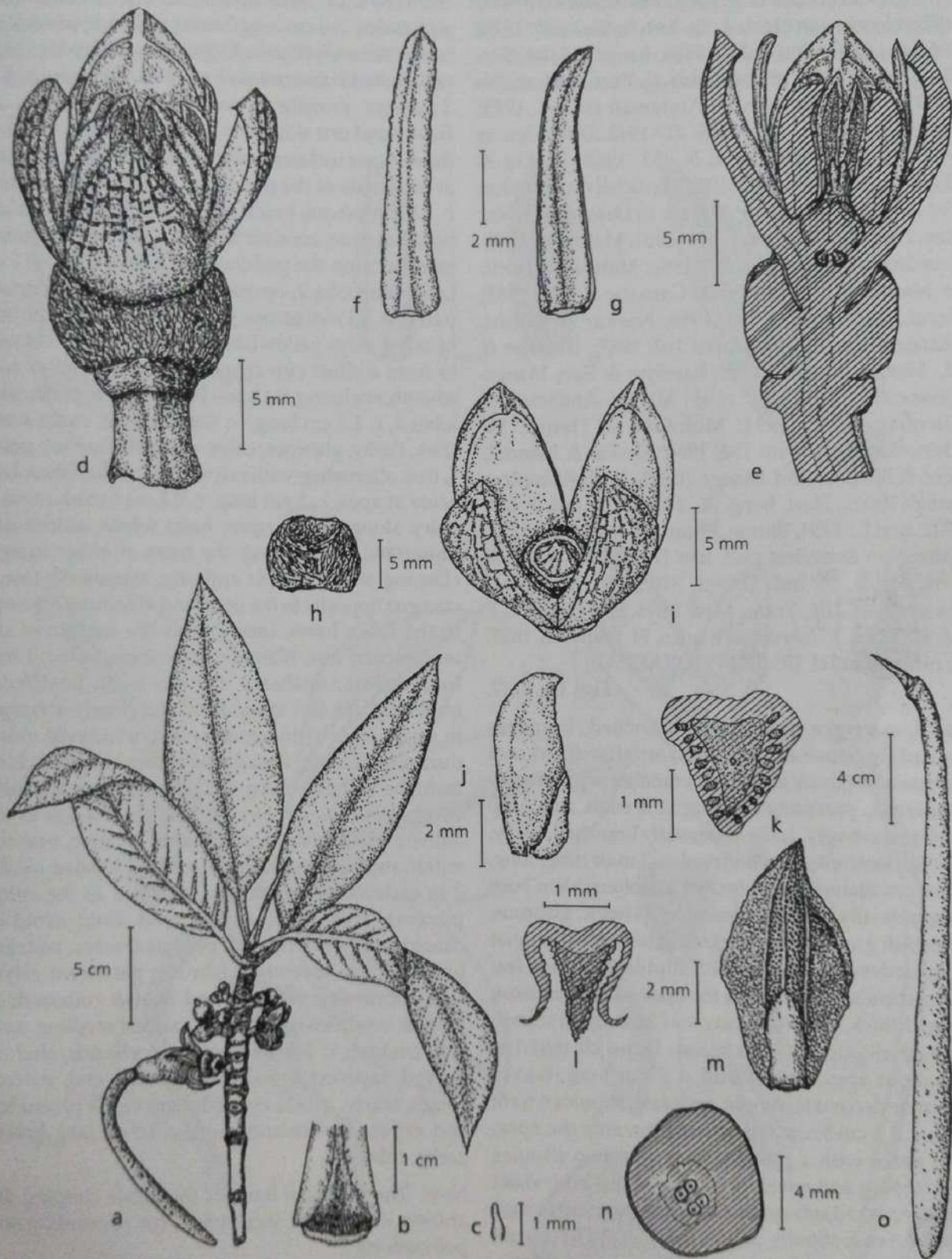


Figure 16. *Rhizophora apiculata* Blume - a. Flowering twig; b. Base of the stipule showing colleters; c. Single colleter; d. Inflorescence with single flower; e. L.S. of inflorescence passing through single flower; f. Petal - dorsal side; g. Petal - ventral side; h. Connate bracteoles; i. Flower with petals and stamens removed; j. Single stamen; k. C.S. of a young anther; l. C.S. of a dehiscent anther; m. Stamen - after dehiscence; n. Ovary - C.S.; o. Viviparous seedling - detached at maturity;

Enum. Pl. Zeyl. 120. 1859; Kurz, For. Fl. Burma 1: 447. 1877; Henslow in Hook. f., Fl. Brit. India 2: 435. 1879; Trimen, Fl. Ceylon 2: 151. 1894; King, J. Asiat. Soc. Bengal 66 (2): 312. 1897; Gamble, Fl. Pres. Madras 456. 1919; Parkinson, For. Fl. Andaman Is. 164. 1923; Holthuis & Lam., Blumea 5: 217. 1942; Ding Hou in van Steenis, Fl. Males. I, 5: 453. 1958; Backer & Bakhuizen, Fl. Java 1: 380. 1963; Arulchelvam, Ceylon For. 8: 65. 1969; Macnae & Fosb. in Dassan. & Fosb., Rev. Handb. Fl. Ceylon 2: 491. 1981; Matthew, Ill. Fl. Tamilnadu Carnatic 2: t. 260. 1982; Matthew & Britto in Matthew, Fl. Tamilnadu Carnatic 3: 574. 1983; Toml., Bot. Mangr. 340. 1986; Naskar & Bakshi, Mangr. Swamp. Sundarbans 162. 1987; Banerjee *et al.*, Mangr. India 84. 1989; Banerjee & Rao, Mangr. Orissa 71. 1990; Dagar *et al.*, Mangr. Andaman & Nicobar Is. 65. 1991; Mohanan & Henry, Fl. Thiruvananthapuram 180. 1994; Naskar & Mandal, Ecol. & Biodiver. Ind. Mangr. II: 375. 1999. *Rhizophora mangle* Roxb., Hort. Beng. 36. 1814, & Fl. Ind. 2: 459. 1832, non L., 1753; Blume, Enum. Pl. Java 1: 91. 1827. *Rhizophora candelaria* auct. non DC., 1828; Wight & Arn., Prodr. Fl. Ind. Orient. 310. 1834. *Rhizophora macrorrhiza* Griff., Trans. Med. Phys. Soc. Calc. 8: 8, f. 2 & 4-7. 1836. *R. longissima* Blanco, Fl. Filip. 398. 1837. **Pranthankandel**. [RHIZOPHORACEAE].

Figs 15c,d, 17.

Small, evergreen trees, much branched, branches spreading more or less horizontally; trunk not conspicuous; trunk and lower branches supported by numerous, profusely looping stilt roots and prop roots respectively; roots repeatedly branched, corky, woody, lenticellate, cylindrical, c. 3 m or more long, c. 3-9 cm diameter and brown in colour; stem bark longitudinally fissured, brown; twigs terete, glabrous, brownish green, internodes short towards the shoot apex; nodes conspicuous with stipular scars and leaf scars; stipular scar around the node as a prominent, rough, thick, brown layer; leaf scars prominent, broadly elliptic, c. 6 mm broad. *Leaves* clustered at the shoot apex; apical bud c. 9 cm long, leaves opposite-decussate, simple, petiolate; stipules c. 6 cm long, c. 1.2 cm broad, narrowing towards the apex, pale green with a pinkish tinge, the two stipules overlapping and envelopping the apical bud; short densely packed sub-cylindric colleters present at base within of each stipule; petiole c. 2.5-3.5 cm long, pale green; lamina c. 12.5-14.5 x 5.5-8.5 cm, ovate-elliptic, cuneate at base, mucronate at apex, glabrous, thick, leathery, green above, pale green beneath with numerous black dots; midrib prominent beneath, lateral veins inconspicuous, c. 8 pairs. *Inflorescence* axillary cymes, dichotomously or trichotomously

branched or unbranched, 2-4 flowered; main peduncle c. 3-5 cm long, terete, glabrous, pendulous, sometimes ending in 2 flowers; otherwise, main peduncle dichotomously branched, each branch with 2 flowers; sometimes the main peduncle with one flower and one side branch with 2 flowers, thereby 3 flowers per inflorescence; small cupular bracts seen at each node of the peduncle. *Flowers* c. 2.5 cm long, c. 1.5 cm across, bracteate, pedicellate, bracteolate; bracts minute, connate to form a dilated structure at each node on the peduncle; pedicel short, c. 0.5 cm long, bracteoles 2, connate to form a dilated cupular part of c. 2.5 mm across, glabrous, enclosing the base of calyx; calyx yellowish white, sepals fused basally to form a short cup shaped calyx tube; calyx tube smooth, enclosing the basal portion of the pistil; calyx lobes 4, c. 1.2 cm long, c. 6 mm broad, ovate acute, thick, fleshy, glabrous; calyx persistent in fruit; petals 4, free, alternating with calyx lobes, white, lanceolate, acute at apex, c. 1 cm long, c. 0.2 cm broad, densely hairy along the margins; hairs white, unicellular, uniseriate, unbranched; the hairs of either margin clasping anther before anthesis; stamens 8, free, 4 stamens opposite to the petal and 4 stamens opposite to the calyx lobes, inserted on the margin of the receptacular disc; filaments very short, upto c. 1 mm long, terete; anther c. 0.7 cm long, basifixed, multilocellate; loci irregularly and closely arranged in single layer; dehiscence by a short adaxial valve; during dehiscence the adaxial anther wall detaching from the anther, rolling out and standing obliquely as a pointed tubular structure on ventral side of the anther; pistil conoid; ovary semi-inferior, inserted within and fused with the calyx cup, 2-loculed; ovules 2 in each locule, pendulous, attached to the apical placenta; style short; stigma bifid. *Fruit* ovoid or conoid, c. 5-7 cm long with persistent calyx; pericarp brown, thick, leathery, glabrous; persistent calyx-lobes becoming reflexed and brown coloured; 1-seeded; seeds viviparous; viviparous seedling upto c. 50 cm long, c. 1.8 cm diameter, cylindric, slightly curved, tapering towards the radicle end, surface rough, warty, green; cotyledonary collar protruded and exposed on maturity, upto c. 2-5 cm long, green, corky, tubular.

Note: The marginal hairs of the petals clasping the anthers could be a mechanism for preventing self pollination.

Flowering & Fruiting: Mostly throughout the year.

Distribution: Throughout the coasts of the Old World tropics. Common on Indo-West-Pacific shores, from South Africa, Queensland to the Ryukyu Islands. **INDIA:** Throughout the Indian mangals along the

West Coast and the East Coast, and Andaman and Nicobar Islands. **Kerala:** Thiruvananthapuram, Kollam, Alappuzha, Kottayam, Ernakulam, Thrissur, Malappuram, Kozhikode, Kannur and Kasaragode

districts; common along the Malabar Coast.

Uses: The plant is used as firewood. Leaves are used as fodder. Tannin is obtained from the bark. Viviparous seedlings are edible.

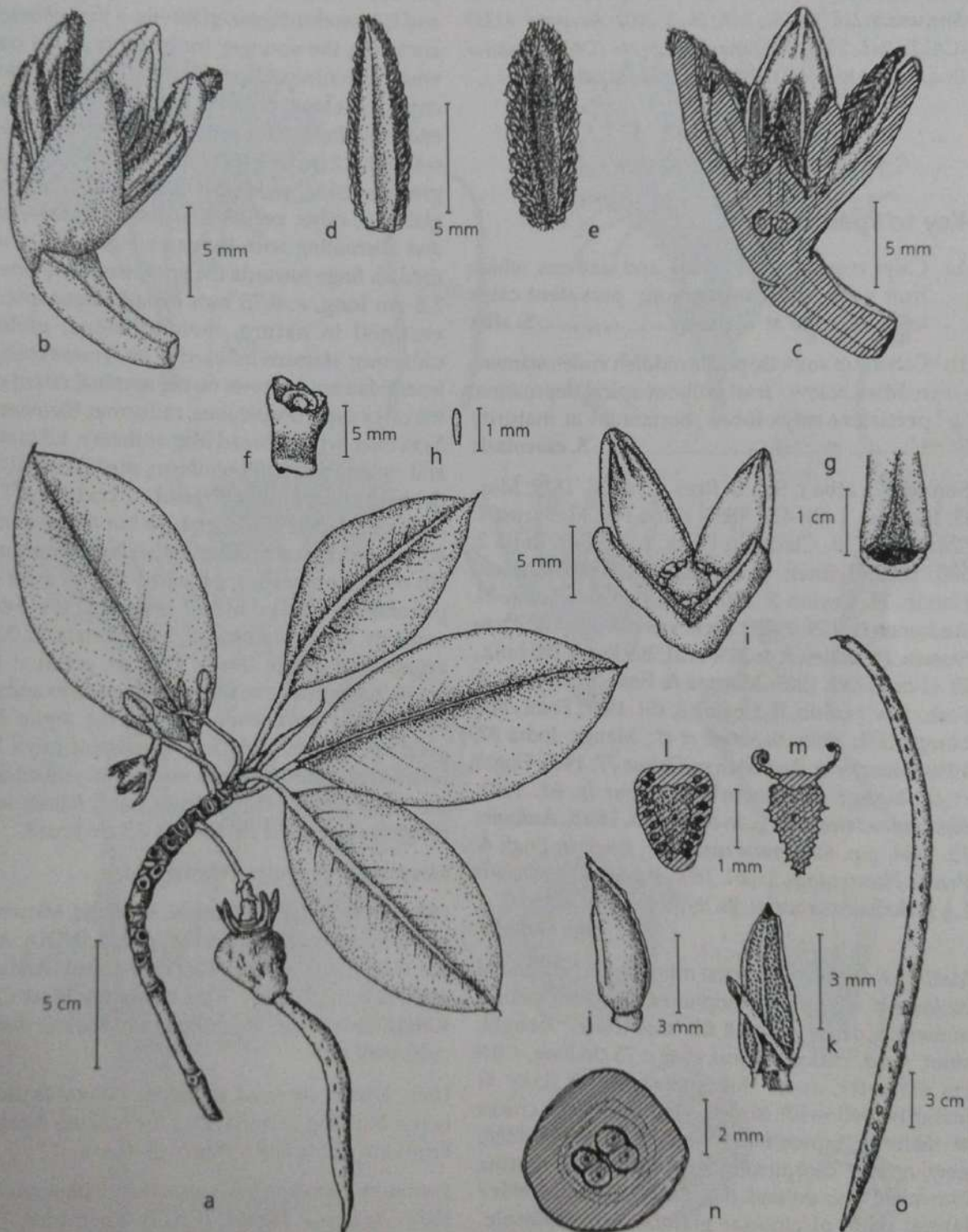


Figure 17. *Rhizophora mucronata* Poir. - a. Flowering twig; b. Flower; c. Flower - L.S.; d. Petal - dorsal side; e. Petal - ventral side; f. Connate bracteoles; g. Base of the stipule showing colleters; h. Single colleter; i. Flower with petals and stamens removed; j. Single stamen; k. Stamen after dehiscence; l. C.S. of a mature anther; m. C.S. of a dehiscent anther; n. Ovary - C.S.; o. Viviparous seedling - detached at maturity.

Specimens Examined: Alappuzha Dist.: Aroor, Sunil 1872 (CALI). Ernakulam Dist.: Kumbalam, 31. 12. 1990, Susaminathan 95697 (MH); Puthuvypu, 14. 8. 2004, Anupama 81299 (CALI). Thrissur Dist.: Chavakkad, 6. 2. 1984, Ramamurthy 80866 (MH); Chettuva, 9. 1. 2004, Anupama 81281 (CALI). Kozhikode Dist.: Kolavipalam, 13. 2. 2002, Anupama 81216 (CALI); *Ibid.*, 26. 3. 2002, Anupama 81230 (CALI); *Ibid.*, 29. 4. 2002, Anupama 81246 (CALI). Kannur Dist.: Madakkara, 26. 6. 2004, Anupama 81289 (CALI).

Sonneratia L. f.

Suppl. Pl. 38, 252. 1782 (*nom.cons.*).

Key to species

- 1a. Calyx cup angular; petals and stamens white; fruit with apical depression; persistent calyx lobes reflexed at maturity..... **S. alba**
- 1b. Calyx cup smooth; petals reddish violet; stamens reddish below; fruit without apical depression; persistent calyx lobes horizontal at maturity..... **S. caseolaris**

Sonneratia alba J. Sm. in Rees, Cycl. 33. 1819; Miq., Fl. Ind. Bat. 1 (3): 497. 1855; Kurz, For. Fl. Burma 1: 526. 1877; C.B. Clarke in Hook. f., Fl. Brit. India 2: 580. 1879; Trimen, J. Bot. 23: 171. 1885; Trimen, Handb. Fl. Ceylon 2: 230. 1894; Parkinson, For. Fl. Andaman Is. 179. 1923; Backer & van Steenis in van Steenis, Fl. Males. I, 4: 285. 1951; Backer & Bakhuizen, Fl. Java 1: 258. 1963; Macnae & Fosb. in Dassan. & Fosb., Rev. Handb. Fl. Ceylon 3: 451. 1981; Toml., Bot. Mangr. 371. 1986; Banerjee *et al.*, Mangr. India 87. 1989; Banerjee & Rao, Mangr. Orissa 77. 1990; Dagar *et al.*, Mangr. Andaman & Nicobar Is. 67. 1991. *Rhizophora caseolaris* L. in Stickman, Herb. Amboin. 13. 1754, p.p. *Sonneratia caseolaris* Engl. in Engl. & Prantl, Pflanzenfam. 1: 261. 1897, p.p. [*non S. caseolaris* L.]. **Nakshathrakandel**. [SONNERATIACEAE].

Figs 15e,f, 18.

Medium sized evergreen trees, much branched, radial cable roots with pneumatophores; pneumatophores numerous, dense around the tree trunk, straight, stout, hard, corky, conical, each c. 75 cm long, c. 0.8 cm diameter, outer thin surface layer flaky at maturity, yellowish brown; stem bark with cracks at maturity, brown; twigs terete, glabrous, reddish grey; nodes conspicuous, swollen with a narrow brownish layer around the node; each node with 2 lateral pairs of circular glands. *Leaves* simple, petiolate; petiole c. 0.5-1 cm long, white or pink; lamina 4.5-11 x 3-9 cm, elliptic, broadly elliptic, oval, obovate, oblong or sub-orbicular, cuneate at base, obtuse at apex, glabrous, coriaceous, thick, slightly

fleshy, green; midrib prominent beneath, lateral veins c. 7-13 pairs. *Flowers* in terminal, axillary or leaf-opposed clusters of 2, 3, or rarely solitary, not arranged into definite inflorescences; each flower c. 6.5 cm long, c. 8 cm across, pedicellate, ephemeral; pedicel c. 1-4 cm long, differentiated into nodes and internodes, terete, glabrous, a pair of bracteoles enclosing the younger buds; calyx green outside, white within; sepals fused basally to form a cup; calyx cup c. 2 cm long, c. 2.5 cm across, angular, glabrous, enclosing the basal portion of the pistil; calyx lobes 6-8, each c. 2 cm long and c. 1 cm broad, oblong, acute, green outside, reddish within, thick, coriaceous, glabrous; calyx persistent in fruit; petals as many as and alternating with the calyx lobes, white with a reddish tinge towards the apex, narrowly linear, c. 2.6 cm long, c. 0.75 mm broad, inconspicuous, vestigial in nature, membranous, glabrous, caducous; stamens inflexed in bud, numerous, free, inserted in several rows on the terminal raised rim of the calyx cup, conspicuous, caducous; filaments c. 4-5 cm long, white, thread like; anthers c. 1.5 mm long and as long as broad, reniform, medifixed, bilobed, dehiscing longitudinally; pistil c. 7 cm long, c. 1.5 cm across, glabrous, white, globose but flattened above with a depression around the stylar base; locules c. 20; ovules numerous, attached to the axile solid placenta; style coiled in bud, extending to c. 6 cm on maturity, white, terete; stigma capitate, c. 0.5 cm across, pale green. *Fruits* globose, green, c. 4 cm across, flattened above with persistent calyx and style, and with a depression around the stylar base; pericarp smooth, glabrous; persistent calyx lobes reflexed at maturity; seeds numerous, embedded in the fleshy pulp of the placenta, hard, falcate with a rough surface, c. 1.5 cm long, c. 0.5 cm broad.

Flowering & Fruiting: February-May

Distribution: India, E. Africa, N. Australia, Micronesia, Malaysia, New Guinea, and Myanmar. **INDIA:** Along the West Coast and the East Coast, and Andaman and Nicobar Islands. Rare along the West Coast. **Kerala:** Ernakulam, Kozhikode and Kannur districts only; very rare.

Uses: Leaves are used as fodder. Wood is used as house building material and for making furniture. Fruits are edible and a source of tannin.

Specimens Examined: Ernakulam Dist.: Puthuvypu, 14. 8. 2004, Anupama 108304 (CALI) Kozhikode Dist.: Kolavipalam, 13. 2. 2002, Anupama 81218 (CALI); *Ibid.*, 26. 3. 2002, Anupama 81232, 81236 (CALI); *Ibid.*, 27. 6. 2002, Anupama 81272 (CALI). Kannur Dist.: Madakkara, 26. 6. 2004, Anupama 81286 (CALI).

Sonneratia caseolaris (L.) Engl. in Engl. & Prantl, Pflanzenfam. 1: 261. 1897; J. Sm. in Rees, Cycl. 33. 1819; Gamble, Fl. Pres. Madras 515. 1919; Parker, Ind. For. 51: 507. 1925, incl. var. *mucronata* Miq., 1860; Backer & van Steenis in van Steenis, Fl. Males. 1, 4:

283. 1951; Backer & Bakhuizen, Fl. Java 1: 258. 1963; Arulchelvam, Ceylon For. 8: 75. 1968; Macnae & Fosb. in Dassan. & Fosb., Rev. Handb. Fl. Ceylon 3: 452. 1981; Toml., Bot. Mangr. 368. 1986; Naskar & Bakshi, Mangr. Swamp. Sundarbans 166. 1987; Nicols.,

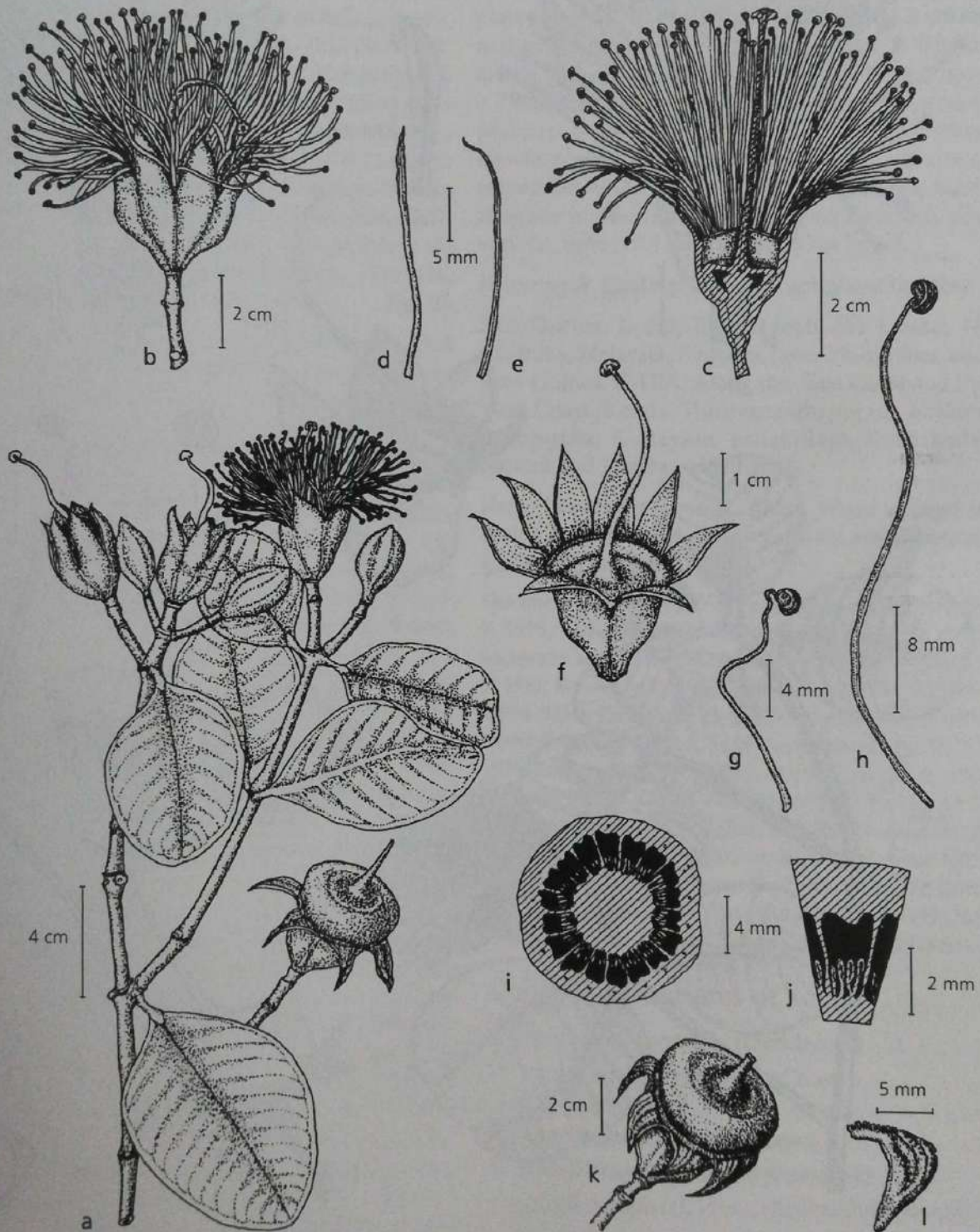


Figure 18. *Sonneratia alba* J. Sm. - a. Flowering twig; b. Flower; c. Flower - L.S.; d. Petal - dorsal side; e. Petal - ventral side; f. Flower with petals and stamens removed; g. Single stamen; h. Dehiscent stamen; i. Ovary - C.S.; j. A portion of C. S. of ovary - magnified; k. Fruit with persistent calyx; l. Seed.

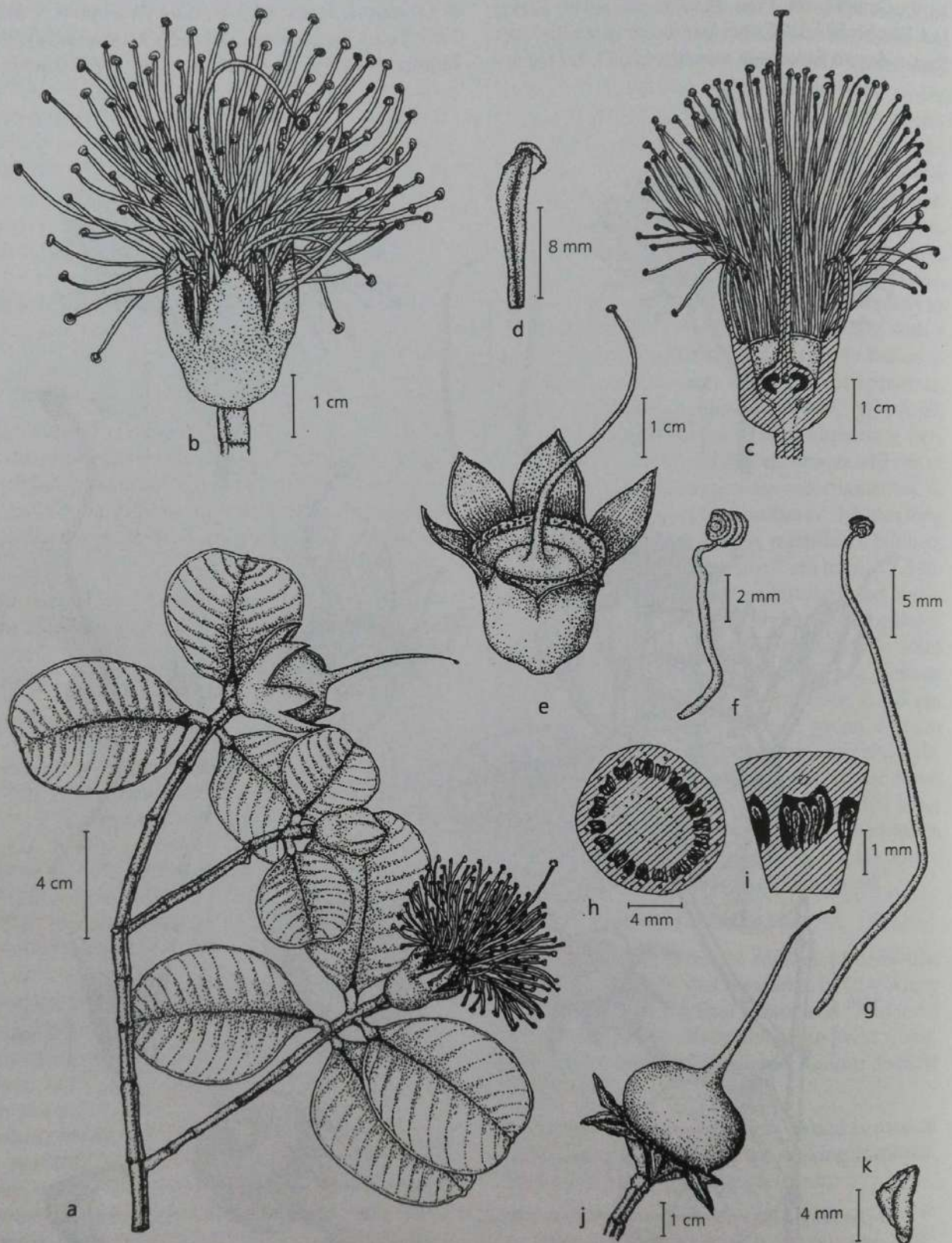


Figure 19. *Sonneratia caseolaris* (L.) Engl. - a. Flowering twig; b. Flower; c. Flower - L.S.; d. Petal; e. Flower with petals and stamens removed; f. Single stamen; g. Dehiscent stamen; h. Ovary - C.S.; i. A portion of C.S. of ovary - magnified; j. Fruit with persistent calyx, style and stigma; k. Seed.

Suresh & Mani., An Interpr. Hort. Malab. 252. 1988; Banerjee *et al.*, Mangr. India 90. 1989; Banerjee & Rao, Mangr. Orissa 76. 1990; Dagar *et al.*, Mangr. Andaman & Nicobar Is. 67. 1991; Mohanan & Henry, Fl. Thiruvananthapuram 203. 1994; Naskar & Mandal, Ecol. & Biodiver. Ind. Mangr. II: 422. 1999. *Rhizophora caseolaris* L. in Stickman, Herb. Amboin. 13. 1754; Burm. f., Fl. Ind. 635. 1768. *Sonneratia acida* L. f., Suppl. Pl. 252. 1781; J. Sm. in Rees, Cycl. 33. 1819; Roxb., Fl. Ind. (Ed., Carey) 2: 506. 1832; Wight, Ic. Pl. Ind. Orient. 2: 340. 1840; Thw., Enum. Pl. Zeyl. 123. 1859; Miq., Fl. Ind. Bat. I (3): 495. 1860, incl. var. *mucronata* Miq., 1860; Kurz, For. Fl. Burma 1: 526. 1877; C.B. Clarke in Hook. f., Fl. Brit. India 2: 579. 1879; Trimen, Handb. Fl. Ceylon 2: 230. 1894; Alston in Trimen, Handb. Fl. Ceylon 6: 129. 1931. *Blatti* Rheede, Hort. Malab. 3: 43-44, t. 40. 1682. **Chakkarakandel, Thirala, Puzhamunja.** [SONNERATIACEAE]. **Fig. 19.**

Medium sized evergreen trees, much branched; radial cable roots with pneumatophores; pneumatophores numerous, dense around the trunk, straight, stout, hard, corky, conical, each c. 1 m long, c. 6 cm diameter, outer thin surface layer flaky at maturity, brownish grey or orange-coloured; stem bark with cracks at maturity, brown; twigs slightly pendulous, angled, almost square in cross section towards the tip, glabrous, greenish brown; nodes conspicuous, swollen, with a narrow brown ring all around; each node with 2 lateral pairs of circular glands. *Leaves* opposite-decussate, simple, petiolate; petiole c. 0.5-1 cm long, red; lamina c. 4-11 x 3.5-6.5 cm, broadly ovate, or broadly elliptic, cuneate at base, apex mucronate, emarginate or obtuse, glabrous, coriaceous, thick, slightly fleshy, green; midrib prominent beneath, lateral veins c. 10-15 pairs. *Flowers* terminal, solitary, c. 9 cm long, c. 5-7 cm across, ephemeral, opening in late evening and lasting for only one night, pedicellate; bracts rudimentary, inconspicuous; young buds enveloped by a pair of bracteoles; pedicels short, reduced, c. 0.5-1 cm long, quadrangular, glabrous; calyx green outside, white within, sepals fused basally to form a cup; calyx cup c. 1.8 cm long, c. 2 cm across, smooth, glabrous, enclosing the lower portion of the pistil; calyx lobes 6, each c. 2 cm long, c. 1 cm broad, oblong, elliptic, acute, green outside, purplish white within, thick, coriaceous, glabrous; calyx persistent in fruit, lobes standing horizontally, not reflexed; petals 6, free, alternating with the calyx lobes, purple to violet red, linear, c. 2 cm long, c. 2 mm broad, acuminate, apex wrinkled and coiled, not showy, membranous, glabrous, caducous; stamens inflexed in bud, numerous, free, inserted in several rows on the

terminal raised rim of the calyx cup, conspicuous, caducous; filaments upto c. 4.2 cm long, reddish below, white above, thread like, anthers c. 1.5 mm long, breadth same as length, reniform, medifixed, bilobed, dehiscing longitudinally; pistil c. 7 cm long, glabrous; ovary white, globose, c. 1 cm across; locules c. 20; ovules numerous, attached to the axile solid placenta; style coiled in bud, extending to c. 6 cm on maturity, white, terete; stigma capitate, c. 0.2 cm across, green. *Fruit* globose, slightly flattened, upto c. 7 cm across with persistent calyx and style, green; pericarp smooth, glabrous; persistent calyx lobes standing horizontally, not reflexed; seeds numerous, embedded in the fleshy pulp of the placenta, hard, irregular in shape, angular with rough surface, size various, upto c. 0.8 cm long, c. 0.5 cm broad.

Flowering & Fruiting: Almost throughout the year.

Distribution: India, Bangladesh, Sri Lanka, N. Australia, Malaysia, Sumatra, Java, Philippines, and New Guinea. **INDIA**: Along the East Coast and the West Coast. **Kerala**: Thiruvananthapuram, Kollam, Alappuzha, Kottayam, Ernakulam, Kozhikode, Kannur and Kasaragode districts.

Uses: Leaves are quality fodder. Wood is used in building and furniture making. Fruits are edible and a source of tannin.

Specimens Examined: Thiruvananthapuram Dist.: Veli, 30. 7. 1979, Mohanan 63335 (MH). Kollam Dist.: Kollam backwater area, 23. 5. 1980, Mohanan 68387 (MH). *Ibid.*, 25. 5. 1980, Mohanan 68393 (MH); *Ibid.*, 23. 12. 1979, Mohanan 65024 (MH). Ernakulam Dist.: Cheranelloor, 18. 8. 1979, Suresh & Manilal 32902 (CALI); Kumbalam bridge, 31. 12. 1990, Swaminathan 95702 (MH); Puhtuvypu, 14. 8. 2004, Anupama 108305 (CALI). Kozhikode Dist.: Feroke, 19. 2. 2002, Anupama 81219 (CALI); *Ibid.*, 13. 5. 2002, Anupama 81258 (CALI). Kannur Dist.: Payyannur, 26. 12. 1980, Ansari 70024 (MH); Thaliparamba, Kuppam river side, 18. 2. 1913, Barber 8794 (MH). Kasaragode Dist.: Kumbala, 25. 1. 1979, Nair 59873 (MH); *Ibid.*, 25. 1. 1979, Ramachandran 59224 (MH).

Mangrove associates of Kerala

1. *Acrostichum aureum* L. (Pteridaceae)
2. *Aniseia martinicensis* (Jacq.) Choisy (Convolvulaceae)
3. *Annona glabra* L. (Annonaceae)
4. *Ardisia littoralis* Andr. (Myrsinaceae)
5. *Bacopa monnieri* (L.) Pennell (Scrophulariaceae)
6. *Barringtonia racemosa* (L.) Spreng. (Lecythidaceae)
7. *Brachiaria distachya* (L.) Stapf (Poaceae)
8. *Caesalpinia crista* L. (Fabaceae)

9. *Caesalpinia nuga* Ait. (Fabaceae)
10. *Calophyllum inophyllum* L. (Clusiaceae)
11. *Cayratia trifolia* (L.) Domin (Vitaceae)
12. *Cerbera odollam* Gaertn. (Apocynaceae)
13. *Clerodendrum inerme* (L.) Gaertn. (Verbenaceae)
14. *Crinum defixum* Ker-Gawl. (Amaryllidaceae)
15. *Cyperus malaccensis* Lamk. (Cyperaceae)
16. *Dalbergia candanensis* (Dennst.) Prain (Fabaceae)
17. *Derris scandens* (Roxb.) Benth. (Fabaceae)
18. *Derris trifoliata* Lour. (Fabaceae)
19. *Diplachne fusca* (L.) P. Beauv. ex Roem. & Schult. (Poaceae)
20. *Dolichandrone spathacea* (L.f.) K. Schum. (Bignoniaceae)
21. *Erythrina fusca* Lour. (Fabaceae)
22. *Fimbristylis ferruginea* (L.) Vahl (Cyperaceae)
23. *Fimbristylis cymosa* R. Br. (Cyperaceae)
24. *Fimbristylis polytrichoides* (Retz.) Vahl (Cyperaceae)
25. *Fimbristylis pubisquama* Kern (Cyperaceae)
26. *Flagellaria indica* L. (Flagellariaceae)
27. *Heliotropium curassavicum* L. (Boraginaceae)
28. *Heritiera littoralis* Dryand. (Sterculiaceae)
29. *Ipomoea companulata* L. (Convolvulaceae)
30. *Ipomoea pes-caprae* (L.) R. Br. (Convolvulaceae)
31. *Mariscus javanicus* (Houtt.) Merr. & Metcalfe (Cyperaceae)
32. *Morinda citrifolia* L. (Rubiaceae)
33. *Pandanus odoratissimus* L. f. (Pandanaceae)
34. *Parsonia alboflavescens* (Dennst.) Mabb. (Apocynaceae)
35. *Paspalum distichum* L. (Poaceae)
36. *Phragmites karka* (Retz.) Trin. ex Steud. (Poaceae)
37. *Pongamia pinnata* (L.) Pierre (Fabaceae)
38. *Premna serratifolia* L. (Verbenaceae)
39. *Sauropus bacciformis* (L.) Airy Shaw (Euphorbiaceae)
40. *Scaevola sericea* Forst. f. ex Vahl (Goodeniaceae)
41. *Schoenoplectus littoralis* (Schrud.) Palla (Cyperaceae)
42. *Sphenoclea zeylanica* Gaertn. (Sphenocleaceae)
43. *Sporobolus virginicus* (L.) Kunth (Poaceae)
44. *Syzygium travancoricum* Gamble (Myrtaceae)
45. *Talipariti tiliaceum* (L.) Fryxell (Malvaceae)
46. *Thespesia populnea* (L.) Soland. ex Corr. (Malvaceae)

47. *Tylophora tetrapetala* (Dennst.) Suresh (Asclepiadaceae)
48. *Wedelia chinensis* (Osbeck) Merr. (Asteraceae)
49. *Zoysia matrella* (L.) Merr. (Poaceae)

Floristic Analysis

Chapman (1976) estimated a total of 90 mangrove species from tropical and sub-tropical regions of the world. Tomlinson (1986) recognized a total of 114 mangrove species all over the world and categorized them into major and minor elements of the mangal and the mangal associates. But Duke (1992) accounted only 69 mangrove species belonging to 26 genera and 20 families. By recounselling common features from Tomlinson (1986) and Duke (1992), Kathiresan and Bingham (2001) recognized only 65 mangrove species under 22 genera and 16 families. In India, 69 true mangrove species have been identified (Kathiresan, 2004).

During the present investigation 15 true mangrove and 49 mangrove associate species were collected from the Kerala coast. The 15 true mangrove species belonged to 9 genera spread over 7 families. The family Rhizophoraceae is the most represented one with 6 species belonging to 3 genera. This indicates a fairly rich species diversity even in the present, highly degraded condition. The true mangrove species are confined to the salty-marshy environment along the backwaters and rivers, whereas the mangrove associates were also found outside the mangrove environments.

Distribution pattern of various true mangrove species in Kerala coast is interesting. *Acanthus ilicifolius*, *Excoecaria agallocha*, *Avicennia officinalis* and *Rhizophora apiculata* are found very common throughout Kerala coast. *Aegiceras corniculatum*, *Avicennia marina*, *Bruguiera cylindrica*, *Kandelia candel* and *Rhizophora mucronata* are more or less common along Malabar Coast but rare along Travancore Coast. *Sonneratia caseolaris* is occasionally found along Malabar as well as Travancore Coast, whereas *Bruguiera gymnorrhiza*, *Bruguiera sexangula*, *Excoecaria indica*, *Lumnitzera racemosa* and *Sonneratia alba* are found rare along Kerala Coast.

The dominance of some species in some particular areas was noted. However, reasons for such dominance have not yet been analyzed. *Avicennia officinalis* attains its maximum abundance along the Kallai and Chaliyar river banks near Beypore (Kozhikode Dist.) and at Thalassery (Kannur Dist.) while *Avicennia marina* dominates in Kunhimangalam (Kannur Dist.). *Rhizophora apiculata* grows luxuriantly in Chittari

(Kasaragode Dist.) and Kumarakam (Kottayam Dist.) while *Rhizophora mucronata* in Kannamali and Edappally near Cochin (Ernakulam Dist.) and in Pazhayangadi (Kannur Dist.). *Bruguiera gymnorrhiza* forms an important population at Kumarakam and *B. cylindrica* at Kunhimangalam and Pazhayangadi. Luxuriant growth of *Kandelia candel* can be seen at Pappinisseri, Chirakkal and Valapattanam estuary (Kannur Dist.). Healthy populations of *Sonneratia caseolaris* are found in Kumarakam with good regeneration whereas *Sonneratia alba* is seen mainly in Koduvalli (Kannur Dist.) and Kolavipalam (Kozhikode Dist.).

Almost all mangrove areas in Kerala are now either in the process of primary succession towards climax or under secondary succession after the destruction of the primary vegetation. Because of the continuous biotic and abiotic interferences, full growth is attained only in a very few localities. The Kannur district supports maximum mangrove areas, and the largest single stretch of mangrove vegetation in Kerala is found at Puthuvypu in Ernakulam District covering about 101 ha.

There were reports from Kerala about the occurrence of mangrove species like *Bruguiera eriopetala*, *B. malabarica*, *B. parviflora* and *Ceriops tagal* in the past. (Drury, 1864; Hooker, 1879-1885; Gamble, 1919; Rama Rao, 1914; Chand Basha, 1992). These species could not be traced during the present investigation. The earlier workers might have misidentified the species or these species might have become locally extinct.

Threats to the Mangroves of Kerala

Increased dependence of coastal community on mangroves as a consequence of population explosion, felling of mangrove trees for timber and firewood, letting in large flock of animals for grazing in mangroves, pressure on coastal tract due to the development of agriculture and horticulture, establishment of factories for tiles, textiles, timber stacking, plywood and other soft wood industries, construction of fishing ports, formation of National Highways, State Highways and Railways through mangrove areas, coconut husk retting, coir processing, wide spread expansion of prawn farms around mangroves etc. are noticed during the present survey. All these constitute major threats to mangrove areas.

Since the existence of this ecosystem is vital for the well-being of all associated flora and fauna, intensive and extensive conservation and ecosystem restoration programmes should be undertaken immediately.

Majority of the mangrove areas in Kerala are under private ownership. Therefore, strict adherence to the protective rules and public awareness on the need of conservation and preservation of this fragile vegetation seems very essential in order to conserve this fragile ecosystem.

Acknowledgements

The authors wish to thank Dr C. N. Sunil (Department of Botany, S. N. M. College, Maliankara, Ernakulam), Messrs M. S. Kiran Raj (Research Associate, Department of Botany, University of Calicut), V. B. Sajeew (Ernakulam), K. A. Ittoop (Kumbalangi, Ernakulam), and P. A. Alby (Siena College, Ernakulam) for various help rendered during the collection trips. The second author acknowledges with gratitude the first Chair in Taxonomy (Plant Science) instituted and conferred on him and the Grant for research in Plant Taxonomy provided by the Ministry of Environment and Forests, Government of India. The facilities provided by the Joint Director, Botanical Survey of India (Southern Circle), Coimbatore, Tamil Nadu for study of the specimens available at MH are acknowledged with thanks.

Literature Cited

- Banerjee, L. K., Sastry, A. R. K. & M. P. Nayar. 1989. *Mangroves in India - Identification Manual*. Botanical Survey of India, Calcutta.
- Blasco, F. 1975. *Les Mangroves de l' Inde. (The Mangroves of India)*. French Institute, Pondicherry.
- Chand Basha, S. 1992. Mangroves of Kerala - A fast disappearing asset. *Ind. For.* 118: 175-190.
- Chapman, V. J. 1976. *Mangrove vegetation*. Cramer, Valduz.
- Drury, H. 1864. *Handbook of Indian Flora* Vol. 1. Travancore Sircar Press, Trivandrum.
- Duke, N. C. 1992. Mangrove floristics and biogeography. In: Roberston, A. I. & D. M. Alongi (Eds), *Tropical Mangrove Ecosystems*. American Geophysical Union, Washington D.C., U. S. A. pp. 63-100.
- Gamble, J.S. 1919. *Rhizophoraceae*. In: Flora of the Presidency of Madras, Vol. 1. Aldard & Son Limited, London.
- Hooker, J. D. 1879- 1885. *Flora of British India*. Vols 2-5. L. Reeve & Co., London.
- Kathiresan, K. 2004. *Mangrove Ecosystems of India*. Annamalai University, Centre of Advanced Study in Marine Biology, Parangipettai, Tamil Nadu.
- Kathiresan, K. & B. L. Bingham 2001. Biology of mangroves and mangrove ecosystems. *Advances in Marine Biology* 40: 81-151.

- MoEF.** 1987. *Mangroves in India – Status Report*. Ministry of Environment & Forests, Government of India, New Delhi.
- Mohanan, C. N.** 1999. Mangroves. In: Thampi, K. B., Nayar, N. M. & C. S. Nair (Eds), *The Natural Resources of Kerala*. WWF India, Thiruvananthapuram. pp. 149-158.
- Naskar, K.R.** 2004. *Manual of Indian Mangroves*. Daya Publishing House, Delhi.
- Rajpurohit, K. S.** 1989. The Biogeography of Indian Mangroves. *Myforest* 25 (1): 1-18.
- Ramachandran, K. K., Mohanan, C. N., Balasubrahmonian, G., Kurien, J. & J. Thomas** 1986. *The Mangrove Ecosystem of Kerala: Its mapping, inventory and some environmental aspects*. (Unpublished Interim Report 1985-86). CESS, Trivandrum.
- Rama Rao, M.** 1914. *Flowering Plants of Travancore*. Government Press, Trivandrum.
- Rao, T. A., Molur, S. & S. Walker (Eds)** 1999. Indian Mangrove Ecosystem. *Zoos'Print* 14(2): 1-33.
- Remadevi, S. & M. S. Binoj Kumar** 2000. *Acanthus ebracteatus* Vahl – An addition to the flora of mainland of India. *J. Econ. Taxon. Bot.* 24 (1): 241-242.
- Tomlinson, P. B.** 1986. *The Botany of Mangroves*. The Cambridge University Press, Cambridge.

Received 20.2.2004

Revised and accepted 15.11.2004